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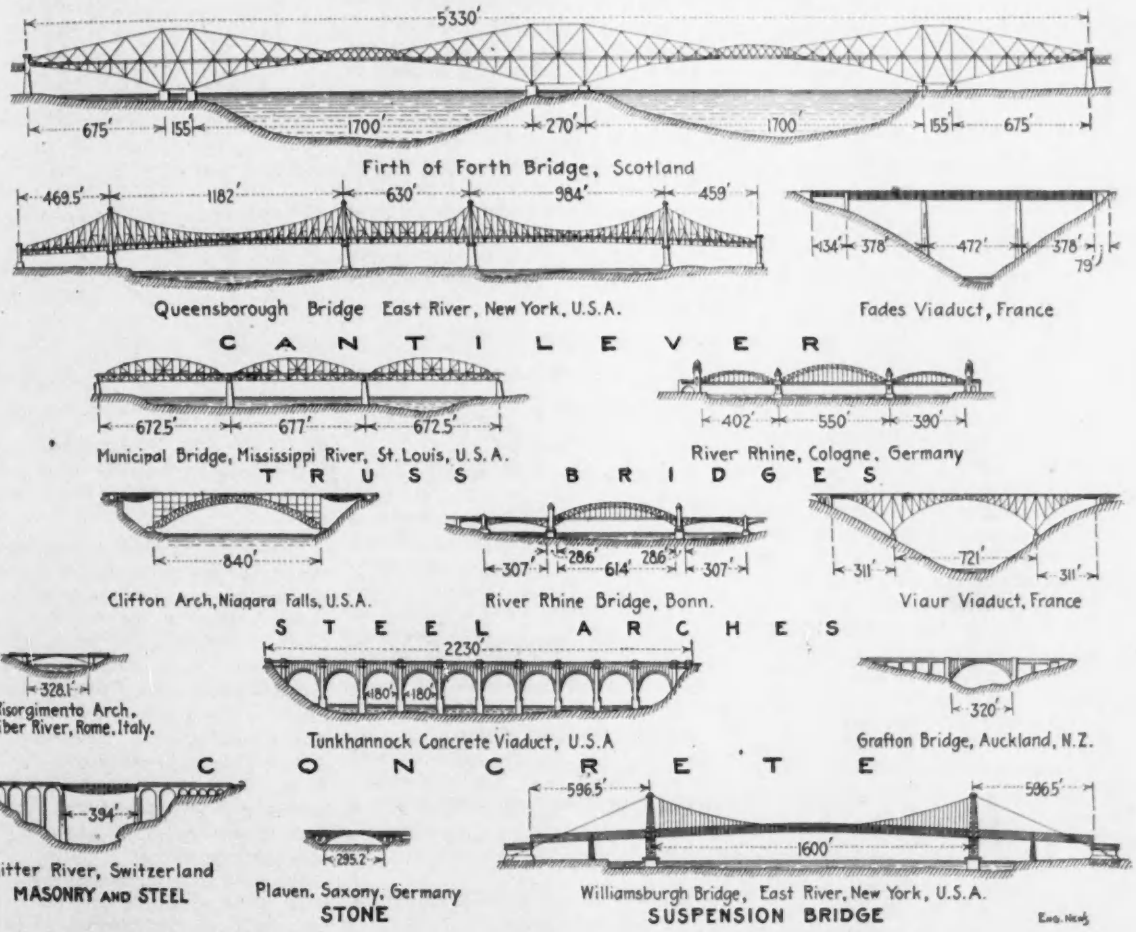
Comparative Outlines of Large Bridges of Different Types

The accompanying diagram, based on one which appeared in *Schweizerische Bauzeitung*, but with a number of additions of our own, gives to the same scale the outline elevations of a number of the world's largest bridges of different types. The largest example of each of the various styles of bridge design is shown. Thus, the Firth of Forth Bridge has the largest cantilever; the Municipal Bridge, the largest single plain truss; the Clifton Bridge, the largest steel arch; the Risorgimento arch, the longest concrete arch; the Plauen Bridge, the longest stone masonry arch, and the Williamsburgh Bridge, the largest suspension bridge.

The new Quebec Bridge, now under construction, like the old bridge, which collapsed in 1907, contains a cantilever span opening (1800 ft.) 100 ft. greater than those of the Firth of Forth cantilever, but the bridge has only one cantilever span and is some 2000 ft. shorter in total length than the Scotch bridge. The Hell Gate Bridge, now under construction across the East River at New York City, is designed to contain a 1000-ft. steel arch, which will be the largest of that type in the world, but the design of the arch has not reached a stage when its outlines can be given out. It should also be noted that the trusses of the Municipal Bridge, at St. Louis, are 668 ft. between end pins and that the dimensions given in the drawing are between center lines of the piers. The Fades viaduct, though built as a cantilever, is in reality a continuous truss.

The limitations in size of the masonry arch are particularly well shown by the drawing. The two longest span concrete arches (Risorgimento and Grafton) and the longest span stone arch (Plauen) are mere pigmies compared with the structures of steel. On the other hand, the new Tunkhannock Creek Viaduct, which the Lackawanna R.R. has now under construction, compares favorably



SOME OF THE WORLD'S LARGE BRIDGES DRAWN TO THE SAME SCALE

in length and height with the largest bridge structures of the world. Though there is small possibility of its ever being built, it may be well to note that the proposed Henry Hudson concrete arch across Spuyten Duyvil gorge at the north end of Manhattan Island is designed for a 703-ft. clear central span. To appreciate that size, compare the 721-ft. Viaur viaduct with the bridge shown just below it, the 320-ft. Grafton arch, which is only 8 ft. shorter and much larger in bulk than the longest-span masonry bridge in the world.

For the benefit of those who may wish to look up further data on the bridges shown, we append the following bibliography:

Bridge	Reference in Eng. News.
Firth of Forth	1890, i, 90; ii, 543.
Queensborough	1905, i, 170.
Fades	1905, i, 585.
Municipal Bridge	1912, i, 231.
Rhine, Cologne	1908, ii, 228.
Rhine, Bonn	1899, i, 242.
Viaur	1900, ii, 158.
Risorgimento	1911, ii, 641.
Tunkhannock	1912, i, 1110.
Grafton	1910, ii, 113.
Plauen	1904, i, 73.
Williamsburgh	1903, ii, 535.

Foundation Weakness in Mississippi Levees*

I have heretofore called attention to foundation weakness as a vulnerable feature of this levee system, the appearance of which at particular places it is not easy to foresee. Wherever such weakness has been disclosed during former high waters, permanent provision was made for security against this danger; and no concern was felt during the recent flood, where such provision had been previously made.

But the increased strain on the foundation of the levee developed very numerous "boils" behind the levee, in many new places. These had to be combated in emergency fashion during the "high-water fight," by the application of bags filled with earth as a temporary device, by which means the "boils" were kept under immediate control.

The principle invoked is the ponding of water over the "boils" and treacherous expanses on the land side of the levee base, and thus reducing the hydrostatic head between the water in the river and that in the ponds behind the levee.

This at once reduces the force of the flow from the boils, or suppresses it in some cases, and also presents a dead water cushion over the orifice, which prevents the dispersion of the material brought from under ground and so stops the displacement going on beneath the surface, which might otherwise enlarge the water passage into a "blow-out," and cause a collapse of the levee.

The permanent provision for correcting this source of danger, is the building of permanent "sub-levees," so as to inclose ponds of water over all such places. These are provided with drain pipes and valves for emptying the ponds after the flood recedes, and with spillways to prevent the overtopping of the sub-levees.

There are now 26 of these sub-levee basins existing along the levee, which have been found indispensable to give security during floods, and as a means of preventing a great deal of very expensive emergency work at such times.

It is regarded as of immediate and grave importance that the system of sub-levee protection shall be now greatly expanded, in order to forestall in the future such high-water fighting as had to be done this season, accompanied by more or less danger of breaks in the levee.

The necessity of providing locations and material for sub-levees, is likely to still further complicate the problem of obtaining material for enlarging the main levee. Some attention has been given to the subject of substituting concrete for earth in some situations, as levee-building material; but there has not yet been opportunity to pursue this study to any prospect of advantageous results; the question, however, merits and shall receive further attention.

*From a Report by T. G. Dabney, Chief Engineer, Yazoo-Mississippi Delta Levee District, on the Flood of 1912.

Wood in Compression; Bearing Values for Inclined Cuts

By Malverd A. Howe*

In a number of structures, such as roof trusses, it is necessary to cut one or both pieces meeting at a joint on a plane making an angle with the direction of the wood fibers. While a large number of experiments has been made to determine the strength of wood in bearing on the ends of the fibers and across the fibers, little or nothing has been published about the bearing on inclined planes.

In 1909, Prof. Jacoby, in "Structural Details or Elements of Design in Heavy Framing," advanced the formula

$$n = p \sin^2 \theta + q \cos^2 \theta$$

where

n = The normal intensity on the inclined plane;

p = The normal intensity on the end of the fibers;

q = The normal intensity across the fibers;

and

θ = The angle made by the plane with the direction of the fibers.

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This formula is theoretically true only when $p = q$, which is seldom, if ever, the case in wood construction. The correct value of n from a purely theoretical standpoint is given by the expression

$$n = \tfrac{1}{2}(p + q) - \tfrac{1}{2}(p - q)\cos^2\theta$$

This expression for n is independent of the physical properties of the material, and hence we have no right to assume that if safe values of p and q are used we will obtain a safe value for n from the above formula. We will obtain a true value of the actual pressure-intensity n, but the material may not be able to resist such an intensity. What we really want is an expression containing p, q and θ, which will give us safe values for n. The simplest way to solve the problem is by experiments.

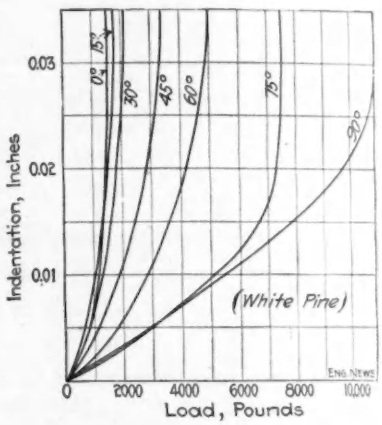

Fig. 1. Typical Stress-Strain Curves for Bearing Pressure on Inclined Cuts; White Pine

In order to get some information about the matter the writer had a number of preliminary experiments made on surfaces inclined to the direction of the fibers, using white pine, yellow pine and white oak. These experiments indicated that n depends upon a fixed relation between p, q and θ, regardless of the particular kind of wood. The experiments were continued by Messrs. A. L. Hyde, O. G. Klenk and C. R. Wallick in connection with their graduating thesis, and their results verified the above statement with two exceptions.

The wood used in the last experiments were white oak, long-leaf pine, white pine and California redwood, all selected from stock carried by lumber dealers in Terre Haute. The angle θ varied from 0° to 90° by steps of 15°. The indentations were carefully measured by a special device for each 500 lb. or 1000 lb. of load until failure took place.

The four woods, long-leaf pine, white pine, white oak and cypress, while radically different in the bearing values p and q, show a remarkable agreement in the law governing the value of n. The

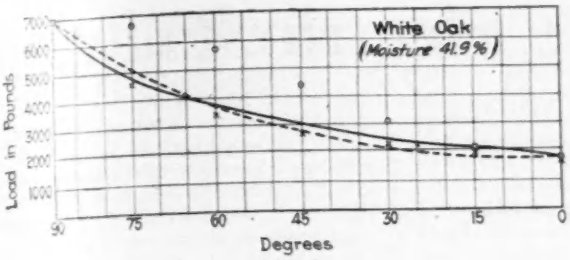

FIG. 2

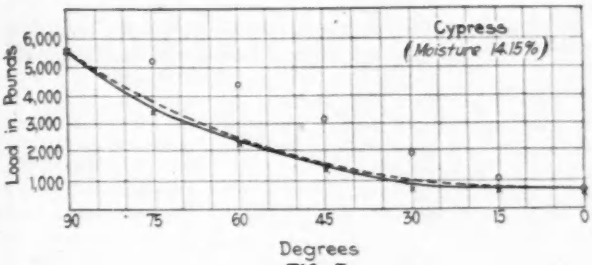

FIG. 3

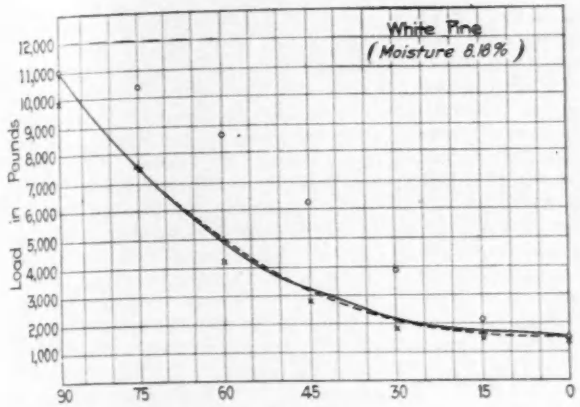

FIG. 4

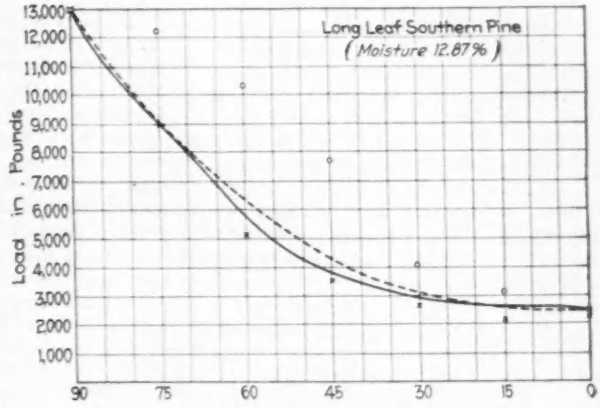

FIG. 5

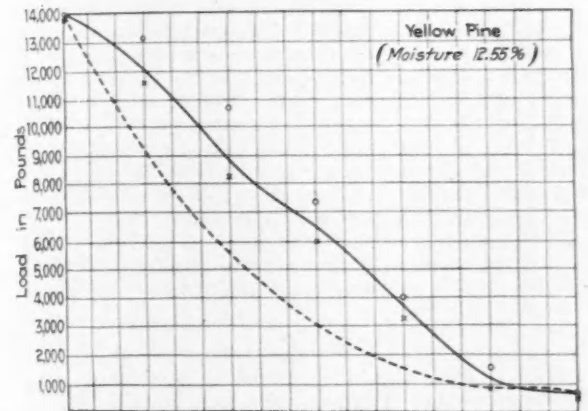

FIG. 6

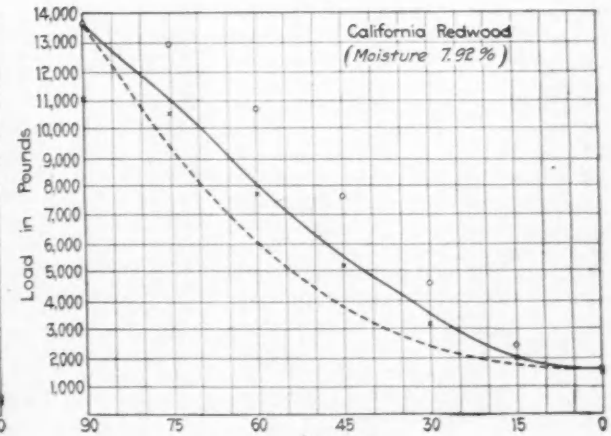

FIG. 7

FIGS. 2-7. BEARING VALUES FOR WOOD ON SURFACES INCLINED TO THE GRAIN AT VARIOUS ANGLES

Circles indicate points from Jacoby's formula,
$$\text{Load} = p \sin^2 \theta + q \cos^2 \theta$$
Crosses indicate points from experiments for 0.02-in. indentation.
Full line gives average results for 0.03 in. indentation.
Dotted line represents formula recommended,
$$\text{Load} = q + (p - q)\left(\frac{\theta^\circ}{90^\circ}\right)^{\frac{1}{2}}$$

expression for n, based on an indentation of 0.03 in., is

$$n = q + (p - q)\left(\frac{\theta^\circ}{90^\circ}\right)^{\frac{1}{2}}$$

The results for yellow pine do not agree at all with the above expression. The wood used in the preliminary experiments agrees perfectly. The second piece of yellow pine was filled with pitch, which may explain the higher values. The results for California redwood also exceed those given by the above expression.

Of course, more experiments are necessary to definitely fix the law of variation for n, but the remarkable agreement between oak and white pine would indicate that the above expression is not greatly in error. In fact, the exponent $\frac{1}{2}$ can be replaced by $\frac{4}{7}$ without serious error, and the writer advocates this form until more experiments are made.

The Bull Mountain Coal Feld in Musselshell Co., Mont., has been examined by the U. S. Geological Survey for the purpose of making a careful estimate of the amount of coal available in that field. The examination shows that the tonnage originally contained in this coal field amounted to 4,797,200,000 short tons. Only a negligibly small quantity of this coal has so far been mined, buf the Geological Survey bulletin states that great activity is now being manifested in the development of this field.

Block Signals on an Electric Railway

By John Leisenring*

The use of the block system as a protection to traffic on electric interurban lines is increasing rapidly, and the present article describes the signal equipment and operating methods of a large interurban system in the Middle West. The signaling does not cover the entire system but is applied partly for continuous stretches a few miles in length and partly for curves, each curve thus protected forming an isolated block section. In this case the signals are of the automatic electric type, practically identical with those used on steam railways, but communication with the dispatcher is by telephone instead of telegraph.

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The art of railway signaling, in one form or another, is almost as old as the railways themselves. The early installations were all of the manual type, automatic signals having come into use quite recently. It is less than 25 years since the first commercial electric car was started in Richmond, Va., and for some time after development was very slow. The past ten years, however, have seen remarkable progress in the electric-railway field. High-speed interurban lines have developed from slow-speed suburban lines, and owing to the rapidity with which the electric roads were extended, little thought was given at first to the matter of signaling.

It is now becoming apparent, however, that some form of adequate control and protection of traffic is needed urgently, and electric roads are becoming more and more interested in the subject of signaling and train control. A number of states, particularly in the Middle West, where the interurban electric lines are most common, have already appointed commissions and proposed laws which will compel some sort of protection, and the Block Signal and Train Control Board of the Interstate Commerce Commission in its latest report also proposes drastic measures along these same lines.

One of the greatest difficulties confronting the electric railway when considering the signal question was that both of the track rails were always used for conducting the return propulsion current from the cars back to the power houses. It was apparent that this current in the rails would continuously energize the one-volt relay as used with track circuits on steam roads. This, therefore, precluded the use of the steam-road signaling system on the electric road; it being out of the question to give up one of the rails for signal purposes. A system was finally developed about 1903 by which both rails could be used for the return current without affecting the alternating current, signaling currents and the controller relays. This was accomplished by using a balanced impedance bond connected across the rail insulations at the ends of each track circuit, these bonds offering impedance to the passage of the signaling current, but not to an appreciable extent to the passage of the return propulsion current.

The management of the Illinois Traction System has for a long time recognized the need of some form of signal protection, dispatcher's signals having been installed over four years ago. In addition to these, a system of automatic signals was laid out during the fall of 1910 and actual construction work was started Feb. 1, 1911. The Illinois Traction System proper operates about 438 miles of single track on private right-of-way, and six sections of this (a total of 60 miles) have been equipped with continuous block-signal protection, the blocks extending from siding to siding. In addition, automatic signals have been installed to protect 17 separate sections of curved track ranging from one to two miles in length. The extent and location of the signaled territory is shown in Fig. 1; this shows also the location of substations and power houses, and the location and capacity of the signal transformers. Table I gives summarized information as to the signals and block sections.

The arrangement of the signals in a system of this sort is, of course, a most important item, as this will directly affect the ease and flexibility of operation. On continuously protected track, trains following one another are spaced the distance between passing sidings, and opposing trains are given advance notice of the approach of the other train by distant signals which are located not less than 1500 ft. from the sidings. The average distance between the sidings is about two miles, and previous to the in-

TABLE I. BLOCK SIGNAL INSTALLATIONS ON THE ILLINOIS TRACTION SYSTEM

Location	Fed from	Protection mainly for	Track circuit or protection miles	No. of signals: Home	Distant	Total	No. of track circuits
A. Peoria and Mackinaw Jnc.:							
1. Farm Ck. to Morton	Peoria and Morton	5 sidings	8.0	11	10	21	20
2. Morton to Mackinaw Jnc	Morton and Mackinaw	3 sidings	6.6	7	6	13	13
B. Mackinaw Jnc. and Springfield:							
3. Summit	Morton and Mackinaw	Curves and switches	1.8	2	0	2	2
4. Selbytown and Ridgeley	Ridgeley Jnc	Curves and 4 sidings	6.6	9	8	17	16
C. Mackinaw and Bloomington:							
5. Gravel pit	Morton and Mackinaw	Switches	0.5	1	0	1	1
6. Porter	Morton and Mackinaw	Curves	1.8	2	0	2	2
7. Stauts Grove Cem	Danvers	Curves	1.3	2	0	2	2
D. Bloomington and Decatur:							
8. Bloomington to Price Siding	Bloomington	Curves and switches	1.0	2	0	2	2
9. N. of Heyworth	Heyworth	Curves	1.7	2	0	2	2
10. S. of Heyworth	Heyworth	Curves	1.1	2	0	2	2
11. N. of Clinton	Clinton	Curves	0.7	2	0	2	2
12. S. of Clinton	Clinton	Curves	0.8	2	0	2	2
E. Decatur and Springfield:							
13. Rock cut	Riverton (Springfield)	Curves	2.0	2	0	2	2
14. Stephens Creek	Harristown	Curves	1.0	2	0	2	2
F. Decatur and Danville:							
15. W. of Bement	Bement	Curves	0.8	2	0	2	1
16. E. of Bement	Bement	Curves	1.5	2	0	2	1
17. Gravel siding to Cham	Urbana	Curves	2.0	2	0	2	2
18. Grays to 2nd St	Fithian	Curves and switches	5.0	12	10*	22	12
G. Springfield and St. Louis:							
19. Carlinv. Subway	Anderson	Curves	1.1	2	0	2	2
20. Carlinv. to Gillespie	Anderson and Gillespie	Curves and 6 sidings	11.5	12	12	24	23
21. Gillespie to Staunton	Gillespie and Staunton	Curves and 3 sidings	8.0	7	5	12	12
22. Worden Subway	Staunton	Curves	1.8	2	0	2	2
23. Grainey siding	Edwardsville	Curves	2.1	2	0	2	2
24. Edwardsville to Granite City	Edwardsville and Stallings	Curves and 7 sidings	13.6	16	15	31	29

*These signals are lights.

stallation of the signals those sidings in signal territory were extended to a length of about 1000 ft. and double ended, in order to meet the traffic demands and to obviate any change of the signals during the next year or so. Except at meeting points, trains do not enter the sidings at all, proceeding on the main line at speed. At meeting points, however, the first train arriving takes the siding, heading in, and backing out when ready to proceed. This practice is followed without exception.

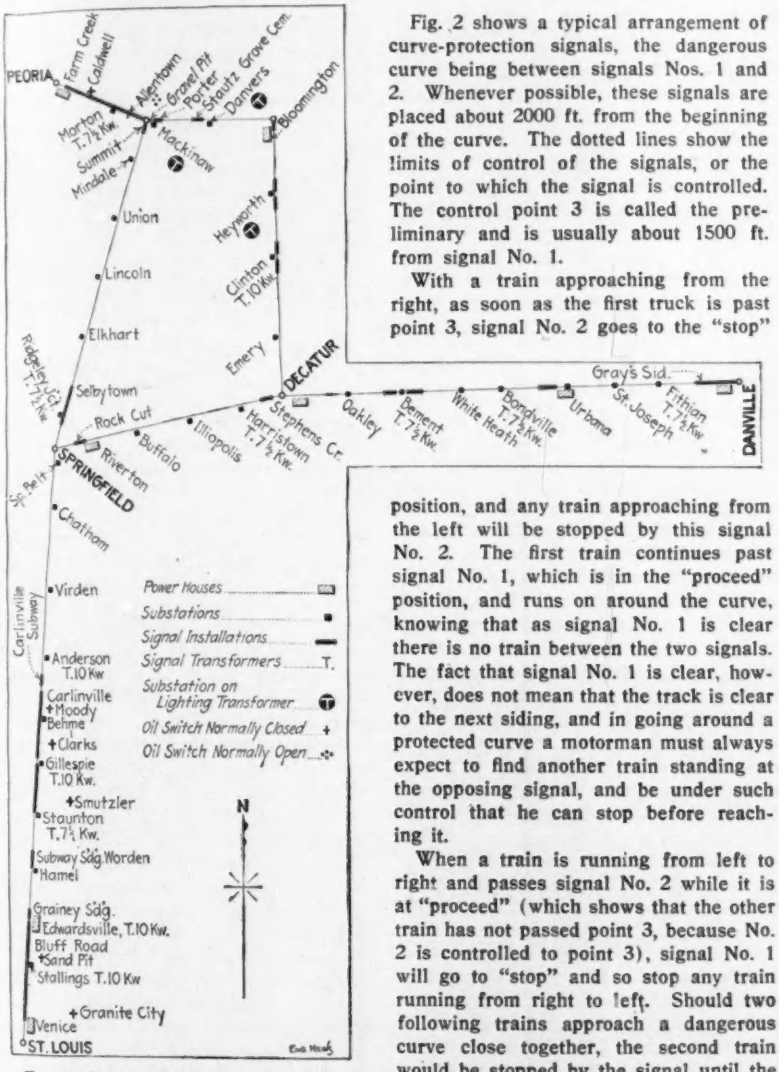

FIG. 1. DIAGRAM PLAN OF THE MAIN LINES OF THE ILLINOIS TRACTION SYSTEM, SHOWING THE LOCATION OF THE SECTIONS PROTECTED BY BLOCK SIGNALS; ALSO THE POWER HOUSES AND SUBSTATIONS

The regular operating interval for passenger trains (except as below) is 60 minutes in either direction, with about six freight trains per day over each division. Between Mackinaw Junction and Peoria trains follow each other as closely as 10 minutes apart, while between Edwardsville and St. Louis a 30-minute schedule is in service. The following abstract of the instructions given in the recently issued supplement to the book of rules describes the arrangement and operation of both the curve and continuous-siding protection signals.

CURVE PROTECTION

Fig. 2 shows a typical arrangement of curve-protection signals, the dangerous curve being between signals Nos. 1 and 2. Whenever possible, these signals are placed about 2000 ft. from the beginning of the curve. The dotted lines show the limits of control of the signals, or the point to which the signal is controlled. The control point 3 is called the preliminary and is usually about 1500 ft. from signal No. 1.

With a train approaching from the right, as soon as the first truck is past point 3, signal No. 2 goes to the "stop" position, and any train approaching from the left will be stopped by this signal No. 2. The first train continues past signal No. 1, which is in the "proceed" position, and runs on around the curve, knowing that as signal No. 1 is clear there is no train between the two signals. The fact that signal No. 1 is clear, however, does not mean that the track is clear to the next siding, and in going around a protected curve a motorman must always expect to find another train standing at the opposing signal, and be under such control that he can stop before reaching it.

When a train is running from left to right and passes signal No. 2 while it is at "proceed" (which shows that the other train has not passed point 3, because No. 2 is controlled to point 3), signal No. 1 will go to "stop" and so stop any train running from right to left. Should two following trains approach a dangerous curve close together, the second train would be stopped by the signal until the first section had passed beyond the limits of control of that signal.

SIDING PROTECTION

In Fig. 3, *A*, *B* and *C* are three sidings with the usual arrangement of signals at each. North is on the right-hand side of the cut, as distinguished by the signal numbers. Signals Nos. 2, 6, 10 and 3, 7 and 11 are distant signals, as shown by the slotted or fish-tail blade, and signals Nos. 4, 8 and 12 and 1, 5 and 9 are home signals. The limits of control of the different signals are shown by the dotted lines. One pair of siding-protection signals is almost exactly similar to a set of curve signals. Take, for instance, the two signals Nos. 4 and 5. These are two opposing home signals, placed like the curve signals in Fig. 5; the preliminary is on the south end at point 2.

A train approaching siding *C* from the right (north) passes signal 11; this has no effect on signals 6 and 8, as they are controlled only to signal No. 9. A train passing signal No. 9, however, will block the opposing train at No. 8 because this signal goes to the "stop" position as soon as signal No. 9 is passed. In the other direction, a train passing No. 6, which is the preliminary for No. 9, will cause signal No. 9 to go to the "stop" position.

Consider that siding *B* is a meeting point and the southbound train is late. If the northbound train should pass signal No. 6 while it is at "proceed" (which shows that there is no train between that signal and signal 9), it might stop the southbound train at signal No. 9 until the northbound train reaches the siding. In this case the train in the siding would have to wait for the southbound train to run from signal 9 to the siding *B* before it could proceed north. If the northbound train waited at signal No. 6 until it went to "caution" (indicating that the southbound train had passed signal No. 9), the northbound train could then proceed to the siding and get into clear without blocking the southbound train and neither train would be greatly delayed.

In the case of a southbound train approaching the meeting point at *B* before signal No. 7 goes to "caution," it can proceed at once to the siding and get into clear, for the reason that signal No. 4 is controlled only up to signal No. 5 and not beyond it to signal No. 7. For ordinary cases when both trains are on time and arrive at the meeting point together, the first train (when possible) takes the siding; the other train stops at the home signal at the far end of the siding until this signal clears.

DESCRIPTION OF SIGNALS

Semaphore signals are used, with the mechanism housed in a box at the base of the pole; the indication of the arm or blade is given in the upper left-hand quadrant, instead of the right-hand, as is customary on steam roads. The signals are also of the two-position type, operating from the horizontal or "stop" position to the 60° or "proceed" position. The reason for using the left-hand quadrant as well as the 60° position for "clear" instead of the vertical position, is self-evident if Fig. 4 is studied. With the signal on the pole-line side of the track, a blade in the right-hand quadrant would be entirely obscured, and a vertical arm being parallel with the line of poles would be inconspicuous or partly obscured.

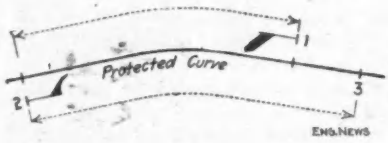

FIG. 2. SIGNAL PROTECTION FOR CURVES

The home signals have pointed blades, as shown in Fig. 5, in order to distinguish them from the interlocking signals encountered at various points along the system. This view shows the switch set for the main track, and the signal standing at "proceed." Beyond the signal is a relay box mounted on a short post, and beyond this again is the switchboard, with its electrically lighted lamp. When the switch is set for the main track it shows a green light and an inclined target or arm (red with a white stripe); when set for the siding it shows a red light and a horizontal target on either side of the open switch. As the operation of the signals depends upon the continuity of the circuit, of which the track rails are a part, a broken rail will open this circuit, and therefore cause "stop" signals to be displayed on either side of the break.

Distant signals (with notched or fish-tail blades, Fig. 6) are used with all home signals in continuous protection, these being located from 1500 to 2000 ft. from the home signal. The northbound distant signals serve the double purpose of repeating the home signal in the customary way as well as indicating to the motorman at meeting points whether or not the opposing train has entered the block, as explained above. The blade of the home signal has the face painted red with a white stripe and the rear side is painted white; the blade of the distant signal has the face painted yellow with a black stripe, and the rear is white. For the night indications, the lamps show red (on the home signal) for "stop"; yellow (on the distant signal) for "caution"; and green (on both signals) for "proceed." Switch indicators are not used except at blind sidings where no signals are installed, as it is possible for the train on the siding to ascertain if the main line is occupied on either side of the siding by simply looking at the home signals, which are located at either end of the siding.*

Each signal is operated by an alternating-current 110-volt motor and an alternating-current slot coil. The mechanism of the signal is at the bottom of the post, and is protected by a sheet-iron case, Fig. 7, the whole being supported on a concrete foundation. An air dashpot is used, and a vertical rod for transmitting the movement to the blade at the top of the pole. On account of overhead clearance the height of the signal is much less than is customary on steam railways, otherwise the signal is identical with that used on steam railways.

The signal lamps are electrically lighted, as are the switch lights in signal territory, two 120-volt lamps of 2 c.p. being used in each. The lamps are arranged in multiple, both burning continuously. For the convenience of the maintainer in hunting trouble at night, a socket has been placed in each signal case so that by inserting the plug of a drop cord all the light required for general inspection can be easily obtained.

The signals are numbered to correspond with the number of miles from a

*At the entrance to Danville it was proposed to put two block sections operated by the staff system, but on account of the delay involved, the railway has put in a trolley-contact signal installation. The fact that the track was laid in a paved street practically prohibited the use of the track circuit.

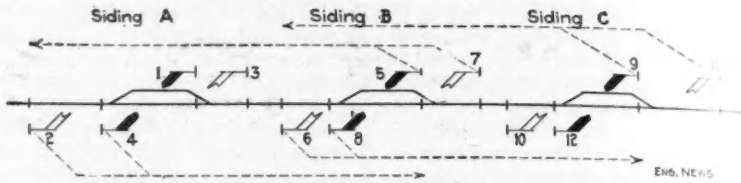

FIG. 3. BLOCK SIGNAL PROTECTION ON MAIN LINE AND PASSING SIDINGS; ILLINOIS TRACTION SYSTEM

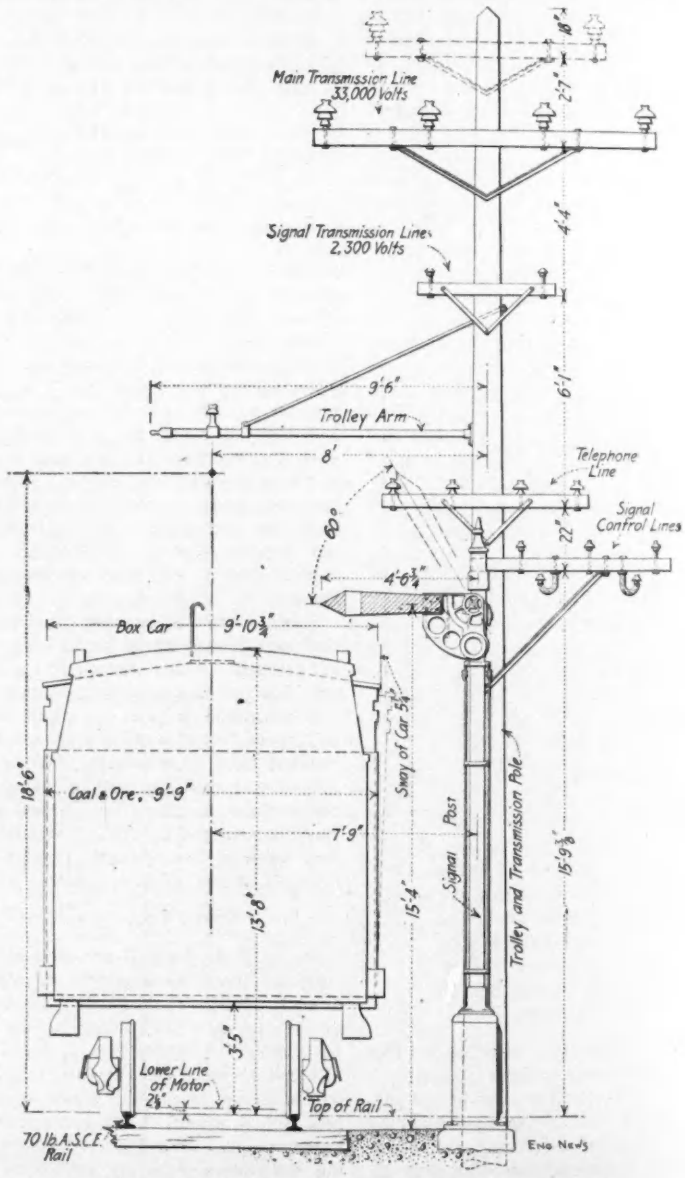

FIG. 4. ARRANGEMENT OF POLES, WIRES AND SIGNALS

predetermined point, the numbers being even or odd as the trains controlled by them bear even or odd numbers. For instance, the first northbound signal beyond

FIG. 5. AUTOMATIC HOME SIGNAL AT PASSING SIDING

mile post 16 will be 160, and the next 162; the first southbound signal beyond the same mile post will be 161 and the next 163. Signal 1690, therefore, is the first northbound signal in the 169th mile from the point of beginning. The numbers are on iron plates on the front sides of the posts.

ELECTRICAL EQUIPMENT

The high-tension signal mains or transmission lines, Fig. 4, are supplied with single-phase current at 2300 volts 25 cycles from the various substations along the line, these being located about 10 or 12 miles apart (Fig. 1). The wires used for transmitting this current are supported on a 4-ft. crossarm, carrying two Western Union pins and deep-grooved double-petticoat porcelain insulators. The wire is No. 9 hard-drawn bare copper, specially drawn to have a greater tensile strength than usual. These arms are mounted on the poles between the 33,000-volt transmission line and the brace of the trolley crossarm.

The usual arrangement of the signal apparatus in the substations, which feed the mains, is as follows: taps are made to the 370-volt side of the large station transformers, which step down the 33,000-volt transmission voltage for the supply of the rotary converter. These taps lead to the primary side of a special oil-cooled signal transformer which steps this 370-volt current up to 2300 volts. The transformers were bought in two sizes, 7½ and 10 kw. capacity, and have a number of 5% taps so that an exact voltage regulation may be secured. From the secondary or 2300-volt side of these transformers, connection is made to the line through an oil circuit-breaker and single-pole single-throw switches. The circuit-breaker is mounted on a special signal panel board on which is also mounted an ammeter and a recording voltmeter. All of the substation equipment was specially made for the installation by the Westinghouse Electric & Mfg. Co. At points where two or more substations feed in on the same signal line, line oil switches mounted on poles are placed midway between the stations. These switches are normally closed, but in times of line trouble it is possible to localize the trouble by opening this oil switch on the pole and the single-throw switches in the substation feeding in that section of the line where trouble exists. In this way the majority of signals are kept in service while repairs are being made.

The typical circuits for curve and continuous protection are shown in Fig. 8. At every other signal a small oil-cooled transformer of about 2 kw. capacity is mounted on a pole and connected to the 2300-volt line through a fused porcelain cutout, and each transformer usually feeds two track sections. These transformers, which are a part of the special signal equipment (all of which was purchased from the Union Switch & Signal Co.), are made with two secondary windings, each winding having a number of taps so that a wide variation in voltage can be secured. The coil feeding the track circuit is capable of adjustment for 8.6, 9.2, 11.8 or 14.5 volts; and that supplying the line can be adjusted for 110, 115, 120, 134 or 146 volts. This latter coil is used for lighting switch and

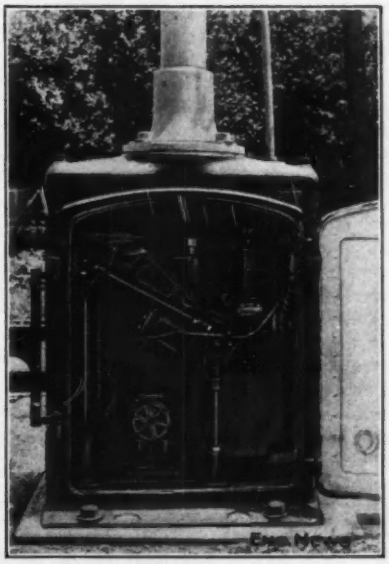

FIG. 7. SIGNAL-OPERATING MECHANISM (AT BASE OF SIGNAL POST)

signal lamps, operating the signal motors and energizing the holding mechanism or slot, as well as for supplying a small relay transformer which is located in the relay box. By the use of these relay transformers a further voltage adjustment is obtainable for the supply of the stationary element of the two-element relay.

FIG. 6. AUTOMATIC DISTANT SIGNAL

The line transformers are protected from lightning by the use of a Westinghouse multi-gap type of arrester. The method of hanging transformers and the location of cut-out plugs and arresters may be seen in Fig. 6. Leads of No. 6 rubber-covered copper wire lead from the track winding of the transformer down the pole to the box containing the impedance coils, arresters, etc. Two impedance coils are used at each transformer location where two track sections are fed. These coils are used in order to limit the flow of current from the transformer in case a train stops opposite the transformer, which would otherwise put a dead short on the track winding of the transformer. The coil is made with an adjustable air gap, the changing of which increases or diminishes the impedance, thereby affording a method of adjusting the voltage on the track as well as the sensitiveness of the track circuit.

Two types of relays are used, the single-element, and the two-element or galvanometer. With the single-element type all of the current for the operation of the relay must come over the track rails and through the wire connections to the relay. This makes the relay uneconomical where long track sections are encountered, as in this case a much higher potential must be impressed on the rails at the transformer end of the circuit in order to insure a sufficient working voltage at the relay.

With the two-element relay, a stationary or field coil is energized directly from the relay transformer mentioned above, at about 110 volts; while the moving armature requires but a small amount of power, which it receives from the rails. The relay is in effect a small motor, and

as the torque of a motor is proportional to the product of the flux in the field and the armature, it is evident that the desired torque to close the contacts may be obtained with a small expenditure of energy in the track-circuit element, by correspondingly increasing the energy in the local element. This latter type of relay, therefore, is used on the longer sections, the longest end-fed section at present in use with a galvanometer relay being 10,600 ft., while a vane relay is used on sections up to 6300 ft. in length. Where the section is very long, it is sometimes necessary to place the transformer in the center of the section and a relay at either end. This method had to be used several times. By this arrangement it is possible to nearly double the maximum distance given above as the limit for an end-fed section.

The relays are housed in an iron box (Fig. 5) on a post near the signal, and containing terminal posts and fuses and the relay transformer. A standard arrangement of wires was carried throughout the installation, wires of similar functions being on similarly situated posts in every instrument case. Besides this, each wire is tagged in each case with a small fiber tag on which is stenciled with a steel stencil the number of the wire and the function controlled or operated by it. This scheme has simplified the maintenance work materially.

At each siding switch, and connected with the normally closed point of the switch, a small circuit controller is located. Through this box the control circuits for the signals on either side of the switch are broken so that any movement of the switch point from its normal position will open the circuit and by cutting off the current cause the signals to go to the "stop" position. In this way protection is given against a train taking an open switch. The box may be adjusted to break contact with various openings of the switch, and in this installation if a switch point is open ⅛ in. it will set the signal at "stop."

The low-tension or control circuits are of No. 10 bare copper wire and are strung on a special alley arm. This was done in order to gain as much clearance from the feeder and other wires on the poles as possible. The wires are also spaced about twice the usual distance, J-pins being used where there are more than three wires on an arm, except at dead ends and double arms. The connection between the line and apparatus is made by the use of rubber-covered wire (conforming to the Railway Signal Association specifications), run in iron conduit and wooden trunking. The latter is used at and for a short distance above the ground level, and the iron above. The leads between the transformer secondary and the rails are of No. 6 rubber-covered copper; those from the rails to the relays of No. 9 copper, and all other runs of No. 14 copper. Channel-pin connections are made at the rail.

One of the most interesting details of the signal system on an electric road is the method of using the rails for both the propulsion current and the signal current through the use of the impedance bonds. These are made up of a number of turns of heavy strip copper wound around a laminated core somewhat like the standard transformer. When connected to the track the propulsion current flowing down both rails in the same direction passes through the bonds in such a manner as to have no magnetic effect on the iron core, whereas when the alternating signal current attempts to flow through the bond from rail to rail it encounters a comparatively high reactance, which causes a part of the current to flow through the track relay. If, however, due to faulty bonding or for other reasons one track rail carries considerable more current than the other, a magnetic effect will be set up in the bond which will, if it becomes too great, interfere with the proper operation of the signals. In order to reduce this magnetizing effect of the unbalanced propulsion current on the bond so that its reactance to the alternating signaling current will undergo but little change, an air gap is introduced into the iron core of the bond. Obviously the reluctance of this air gap considerably reduces the reactance to the signaling current, thus requiring additional signaling current through the bond to maintain the necessary difference in potential in the alternating current between the rails.

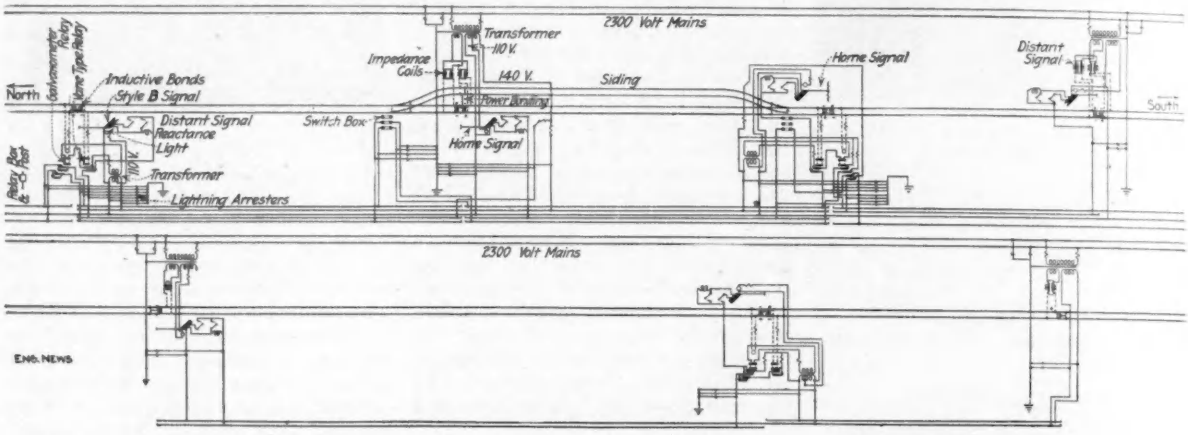

FIG. 8. DIAGRAM OF WIRING FOR AUTOMATIC BLOCK SIGNALS; ILLINOIS TRACTION SYSTEM

OPERATION AND PERFORMANCE

The work of installation was done by a signal gang organized for the purpose and everything was done in as permanent a way as possible, and the remarkable results obtained from the operation of these signals shows that these extra pains were well worth while. Very careful records have been kept of the signal performance and the detailed reports are sent monthly to each maintainer. Table II shows this report for April, 1912. In this way each man is given a chance to see his record compared with those of the other divisions and a friendly rivalry for good records (which means good work) is aroused.

At about the time the first signals were to be put in service, a "signal supplement" to the standard book of rules was issued, giving all rules pertaining to the method of operating under the signals. Schools of instruction were also held, where a small working model was used, and the motormen were encouraged to ask questions. This proved of decided value and little difficulty was experienced after the signals were put in service. An abstract of the important rules included in the supplement is given below, and it should be understood that at each siding there is a telephone (in a cabin) for communication between the trainmen and the dispatcher.

1. Block signals control the use of the blocks, but unless otherwise provided, do

TABLE II. MONTHLY REPORT OF SIGNAL DEPARTMENT; ILLINOIS TRACTION SYSTEM (APRIL, 1912)*

No. of signals	165	
No. of movements	202,844	
No. of failures	44	
No. of trains stopped	63	
Minutes delayed	165	
Movements per failure	4610	
Movements per train stopped	3129	
Movements per minute delayed	1229	
Per cent. perfect operation	97.97%	
Failures chargeable to:		
Signal department	4	
Blown fuse	17	
Defective apparatus	..	
Track department	..	
Power department	3	
Overhead department	5	
Operating department	1	
Broken wire	5	(A)
Miscellaneous	4	(B)
Creditable failures	..	
Bonding	5	

Remarks. A, three of these failures due to wires blown down and crossed with feeder. B, two of these failures due to poles blown over.

*The report as made has eight columns, showing the results for the seven operating divisions and the entire system. We have given only the column of totals for the entire system.—Editor.

not affect the movement of trains under the time card or train rules, nor dispense with the use or observance of other signals whenever required. This system does not affect flagging rules and none of the usual precautions are to be omitted, and rules must be carried out at all times and places in the same manner as if the block signals did not exist.

2. Block signals apply only to trains running in the established direction, and are displayed on the right-hand side of the track. Automatic signals are of the semaphore type and, unless otherwise designated, are positive signals. Indications are given by not more than two positions of the arm, operating in the upper left-hand quadrant; and by lights of prescribed color. The arms that govern are displayed to the left of the post as seen from an approaching train.

3. On home signals the arm in the horizontal position by day (and a red light by night) indicates "stop." The arm at an angle of 60° above the horizontal by day (and a green light by night) indicates "proceed."

4. The arm of the distant signal in the horizontal position by day (and a yellow light by night) indicates "caution"; be prepared to stop at home signal. The arm at an angle of 60° above the horizontal by day (and a green light by night) indicates "proceed," except as noted in No. 10 below.

5. A signal improperly displayed, a white light by night displayed on a signal, or the absence of a signal at a place where a signal is usually shown, must be regarded as a "stop" signal and the fact reported to the dispatcher.

6. When a train is stopped by a block signal that is evidently out of order, after waiting two minutes, the motorman must call up the dispatcher and proceed only after the dispatcher has given the authority for so doing on the form used for a regular order.

7. Reports of detentions to trains by signals must be made by the motorman to the dispatcher by telephone, at once, and a written report sent to the dispatcher and signal engineer on the form provided, upon arriving at the end of the run. Motormen before reporting the cause of the stop as "unknown," must, if possible, ascertain if such stop was caused by a train in the block, an open switch, a broken rail, or some other obstruction.

8. Switches in or leading to the main track are provided with switch boxes so connected to the switch points that opening the switch in any block will cause the home signals governing that block to indicate "stop" and the distant signals to indicate "caution," until the switch is again closed. Cars taking the siding must be stopped clear of the fouling point and insulated track joints, as otherwise the signal for the block in which the siding is located will indicate "stop."

9. Block signals are absolute, except as in paragraph 6, and except that northbound trains may run past a "stop" signal at a meeting point in order to take the siding.

10. Northbound trains approaching a meeting point, and finding the distant signal clear, must stop and (after waiting one minute) call the dispatcher. In case the orders are not changed the train must wait until the distant signal goes to "caution" before proceeding to the siding. This rule applies only to northbound trains at time-card or train-order meeting points.

11. A train having entered the siding and cleared the main line at a meeting point, the conductor must leave the switch set for the siding and remain at the switch until he sees the other train approaching, and knows that it has passed the distant signal. He may then close the switch and give the other train the signal to proceed.

12. Trains taking a siding must in every case back out of said siding. A train entering the main line from a siding (except in the case of a regular time-card or train-order meet), must be protected from the rear by flag, the flagman going back a sufficient distant to insure full protection.

13. Trackmen and other employees will report promptly to the dispatcher and signal engineer by telephone all defects noticed in the block-signal system.

Natural Gas for City Purposes in Hamburg—Natural gas newly discovered near the city of Hamburg, Germany, is to be used for the city lighting in conjunction with the existing gas works, and also for driving some of the engines of the municipal water-works. There is enough gas to supply all the city's lighting requirements, but the natural gas being nearly pure methane, its use would require all burners to be changed, and, therefore, it will be used only as a 15% addition to the coal gas now made. Nearly 1,000,000 cu.ft. of natural gas per day will be used in this way.

Long-Distance Non-Stop Trains in Europe

The longest non-stop trains run on European railways are in England, where there are 11 runs over 150 miles, three of which are over 200 miles (maximum 226), and the average speeds range from 50 to 58 m.p.h. for the entire distance. In Germany, there are five runs of over 150 miles (maximum 178), with speeds of 48½ to 53½ m.p.h. France has only one run of over 150 miles (158), with a speed of 53¾ m.p.h. These figures are from an article by A. Kuntzemuller, in the June number of the Bulletin of the International Railway Congress, this being translated from the *Zeitung des Vereins Deutscher Eisenbahnverwaltungen*. The author states that American railways rank much lower, the longest non-stop run being 141 miles, from Englewood (Chicago) to Fort Wayne, at 59 m.p.h. It is true that the timetables show runs as long as 438 miles, but these include actual stops to change engines, etc. The English runs are for regular trains, but some of the foreign long-distance runs are special steamer trains or international express trains. The accompanying table gives particulars of some of the runs mentioned, which relate presumably to 1911:

LONG NON-STOP TRAIN RUNS ON EUROPEAN RAILWAYS

Train runs	Distance miles	Time min.	Speed m.p.h.
England			
London-Plymouth	226.75	247	55.1
London-Rhyl	209.25	237	52.9
London-Shipley	206.50	245	50.6
London-Liverpool	192.25	215	53.6
London-Wilmslow	176.82	193	55.0
Wakefield-London	175.75	185	57.0
London-Exeter	173.75	180	57.9
Germany			
Berlin-Hamburg	178.20	200	53.4
Munich-Wurzburg	172.20	205	50.4
Berlin-Liegnitz	164.3	203	48.6
France			
Paris-Boulogne	157.8	170	55.7

A Concrete Handling Record with a Lidgerwood high-speed cableway has been established in the construction of the Medina Irrigaton Co. dam in Texas. With a cableway of the same type used to handle construction materials at the Gatun locks, Panama Canal, equipped with the high-speed carriage described in Engineering News of Sept. 14, 1911, shock absorbing fall rope carriers, high-speed balanced hoisting engine and other recent improvements, a record of 32 round trips per hour of a 2-cu.yd. bucket, requiring a 70-ft. hoist, a 700-ft. run and 110-ft. drop was made.

The dam is under construction on the Medina River, about 35 miles from San Antonio. It is to be 166 ft. high, about 550 ft. in length, and will contain about 280,000 cu.yd. of cyclopean concrete masonry. The construction plant is situated on the west end of the dam. The placing of stone and concrete is done by two cableways, one of 1200-ft. span on towers 100 ft. high, and the other of 1180-ft. span on 70-ft. towers. The concrete is made in a large mixer near the 1180-ft. cableway and delivered under the cableway in flat cars in 2-cu.yd. bottom-dump buckets.

Vibrations of Buildings Due to Street Traffic

By Elmer E. Hall*

The vibrations of buildings due to wind gusts and of bridge piers[1] have been measured in particular cases, but so far as the writer is aware little work has been done in measuring the minute vibrations and tremors produced by street traffic. The difficulty, as well as the importance, of the problem of vibrations in buildings is fully recognized. The complexity of structure with resulting complexity of mass distribution and the unknown resultant elastic constants make a purely mathematical solution, for any given case, practically impossible. It is to be expected that the solution will come from the empirical rather than from the purely mathematical side. When the accumulative data, covering a large number of buildings and conditions, shall have become great enough, it is to be hoped that generalizations will be possible, and that definite conclusions and relations may be deduced so as to make it possible to predict with accuracy the period of vibration of a given building and the amplitude of that vibration under the action of a given disturbing force.

It is with the hope that the data here presented may contribute toward the general solution of the problem that the writer gives some of the results obtained in certain buildings in San Francisco. The records were made, seismograph fashion, by fine writing-points on glazed paper lightly coated with kerosene smoke. The records were made permanent by dipping in an alcoholic solution of white shellac. The figures shown are taken from photographs of portions of records and are typical of the various forms of vibrations met with.

Three-story Brick Building

Figs. 1, 2 and 3 are portions of records taken with the recorder on the third floor of a three-story brick building 50 ft. wide, extending from Bush St. to Fern Ave., a distance of 125 ft. The recorder was placed in the rear of the building, near Fern Ave., which is a narrow street paved with cobblestones.

Fig. 1 shows transverse vibrations of the building as a whole, the period of the vibration being 0.53 sec. and the double amplitude 0.036 mm. Superimposed upon the larger vibrations are minute tremors of frequency 8.6 per sec. and of double amplitude 0.004 mm. The minute tremors are due to a 1000-kw. motor-generator running in an adjacent substation of the Pacific Gas and Electric Co. These minute tremors are present on all the records taken in this building and are registered by the vertical as well as by each of the horizontal components.

Simultaneous with the transverse vibrations of Fig. 1 were vertical vibrations of the floor as a whole. The period of this vibration is 0.56 sec. and the double amplitude 0.012 mm. The first floor of the building is occupied by a garage; it is a suspended floor, there being a basement under the entire building. Vertical vibrations of the third floor as a whole are produced by automobiles entering or leaving the garage. Sometimes, as shown by Fig. 1, automobiles also produce transverse vibrations of the building. Street traffic also produced transverse vibrations of the building and both horizontal and vertical tremors, but never gave rise to vibration of the floor as a whole; this type of vibration was met with only in buildings where teams or automobiles entered the building.

Fig. 2 is typical of the transverse vibrations produced by a Sutter St. car striking the Polk St. crossing, about 250 ft. from the part of the building in which the recorder stood. The frequency is about 6 per sec., and the total double amplitude 0.03 mm. At night, lying on a couch, the writer could distinctly feel the stronger vibrations produced by the street cars, but when standing he did not feel the vibrations. For a frequency of 6 per sec. a double amplitude of 0.03 mm. probably marks very approximately the lower limit of perception.

Fig. 3 shows the vertical vibrations produced by a two-horse load of rock on Fern Ave. The frequency is about 7 per sec. The effect of the cobblestone pavement is apparent. These vibrations were readily felt by a person standing.

Motor-generator Substation

The records of Fig. 4 were obtained with the recorder placed on the ground floor of Substation I, Pacific Gas and Electric Co., on Eighth St. The upper line shows the vibration produced by the motor-generator, near which the recorder stood, while the lower line shows a compressional wave due to a passing street car. The frequency of this vibration is 7 per sec. and the double amplitude 0.035 mm.

Six-story Brick Building

Figs. 5 and 6 were taken with the recorder on the roof of a six-story brick building at 445 Sutter St. The building is a Class C building, 48x130 ft. Fig. 5 gives the transverse vibrations of the building; the period is 0.7 sec., and the double amplitude is 0.036 mm. Fig. 6 gives the longitudinal vibrations of the building; the period is 0.37 sec., and the double amplitude is 0.014 mm.

There was very little wind at the time these records were taken. The vibrations are produced by street traffic, but the traffic is so heavy and the vibrations so continuous that it was impossible to ascribe any particular vibration to a definite cause. Minute tremors are frequently present; the most common frequency is 8.9 per sec. These are distortional waves, since they are registered simultaneously by each of the three components. The maximum double amplitude of these minute tremors is about 0.003 mm.

Fig. 7 was obtained with the recorder standing on the concrete basement floor of the same building. The figure shows the vertical vibration produced by a Sutter St. car; the frequency is 21 per sec., and the double amplitude 0.016 mm. The vibrations were also recorded in both the horizontal-component directions, but the amplitude is very much less in the horizontal than in the vertical plane. The recorder stood about 14 ft. from the street curb, to which the basement extended, and was about 12 ft. below the street level. The waves thus bent around a corner. Other vibrations of various frequencies, not due to street cars, were frequent.

Tower of Ferry Building

Figs. 8 to 11, inclusive, are portions of records taken in the tower of the Ferry Bldg. The tower is 32x28 ft., the longer dimension being parallel to the waterfront, and 225 ft. high from sidewalk level to base of flag pole. The roof of the main building at the place where the tower rises is 54 ft. from the sidewalk; the seventh floor, on which the recorder stood, is 87 ft. above the sidewalk. The tower has a steel frame; the walls originally were of brick, but in the reconstruction following the earthquake of 1906 the portions above the main building were made of concrete. The entire building is 650 ft. long by 150 ft. wide, and rests on 5000 piles. The piles are at least 80 ft. long, and their tops are 21 ft. below the sidewalk line. On the piles, which are in clusters, are cross-timbers on which rest concrete arches, bringing the foundation to the street level. The piles are driven in mud, and the building is supported by skin friction.

Fig. 8 represents a typical transverse vibration, while the upper line of Fig. 9 shows the usual longitudinal vibration. The period of the transverse component is 0.86 sec., and of the longitudinal component (parallel to the waterfront) 0.61 sec. The double amplitude is usually about 0.03 mm., the maximum obtained being 0.07 mm. for the transverse and 0.066 for the longitudinal component.

The building is rocking practically all the time. The lower line of Fig. 9, except for the tremors, shows a time of comparative quiet. These particular tremors have a frequency of 13 per sec.

There was little wind when the records were taken. The recorded vibrations

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[1]Japan Earthquake Investigation Committee, 1904-5, p. 106, and 1907, p. 155. See also the other reports of this committee.

seem to be due to traffic. The bumping of the ferryboats as they come in, the splash of the water as the boats leave, street cars, and traffic generally, are the main causes. In the small hours of the night, when traffic has subsided, the vibrations become small, but they do not cease.

Where the recorder stood on the seventh floor, the vibrations of the tower were not perceptible to the senses. The swaying of the tower was, however, distinctly felt as one approached the top of the tower.

Fig. 10 shows the vertical vibrations of the floor as a whole, with a period of 0.7 sec., and also vertical tremors of frequency slightly greater than 7 per sec. which enter before the vibrations of the floor as a whole have stopped.

Fig. 11 represents the results of a continuous run of 48 hr., the arrow showing the direction the writing point moved. This run was made to see whether or not the tide produced any change in level. No such effect was noted. Two opposing influences may be present, a tilting of adjacent land at high tide due to the weight of the added layer of water in the bay, and a horizontal force against the upper part of the foundation of the building due to hydrostatic pressure. The building has, however, the daily period of swing due to temperature changes. About 8 a.m., soon after the sun strikes the building, the building begins to warp. This warping continues until about midnight, when motion in the reverse direction begins. The sun shone brightly the day the record was begun, less brightly the second day. For the seventh floor the change in level amounted to 3.4 in. in a mile, or about 11″ of arc.

Eight-story Concrete Building

Fig. 12 is taken from a record made in the Sheldon Bldg., corner of First and Market Sts. The building, consisting of eight stories and a basement, is built of reinforced concrete. The two wings in the rear are separated by an open court. The recorder stood on the eighth floor in the wing farthest removed from traffic.

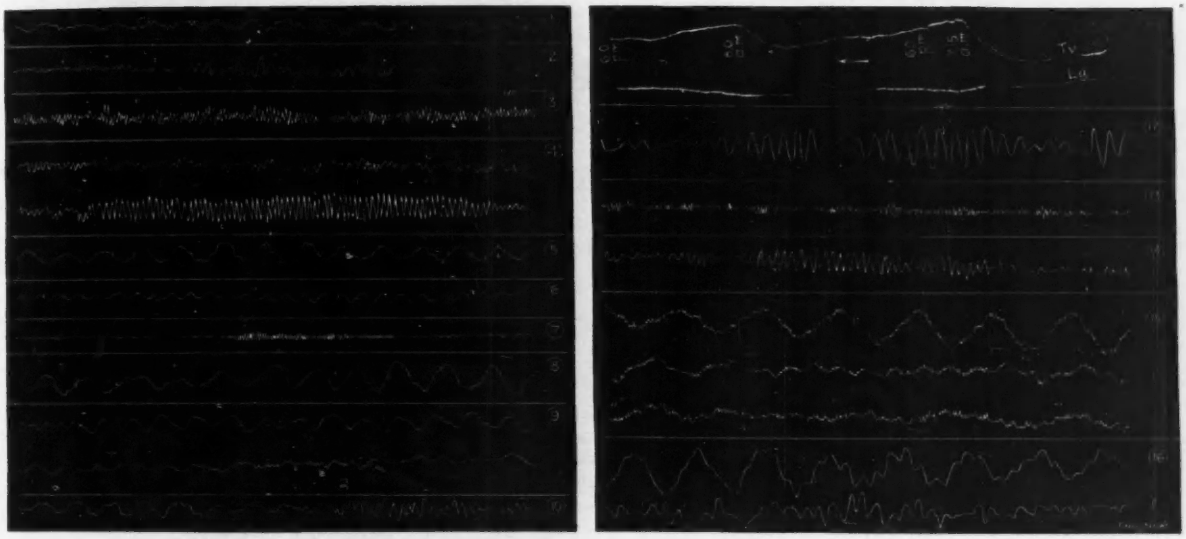
The record (Fig. 12) is typical of the vibrations parallel to Market St. There seem to be two different frequencies, producing "beats." The principal component has a period of 0.4 sec., and the aggregate double amplitude is 0.05 mm. Some overtones are present in the vibrations perpendicular to Market St., and minute tremors also frequently enter. The stopping and starting of elevators produce vertical tremors of frequency 9 to 11 per sec.

The Claus Spreckels Bldg.

Figs. 13 to 16 are taken from records made with the recorder on the 19th floor of the Claus Spreckels Bldg. The building is a steel-frame structure located at the corner of Third and Market Sts., the building being 75x70 ft., the longer frontage on Market St. The height of the building from street level to top of lantern on the dome is 315 ft.; the height of the 19th floor, where the recorder stood, is 270 ft.

The building is practically isolated from other buildings, so far as the problem of vibrations is concerned. The foundations are 25 ft. deep and extend 9 ft. every way outside the building. The steel frame is exceptionally well braced. The building withstood the earthquake of 1906 so well that it was made the subject of a government investigation.*

*Bulletin No. 324, U. S. Geological Survey.



Records of Vibrations of Buildings Due to Street Traffic

Fig. 1. Transverse vibrations of 3-story brick building.
Fig. 2. Transverse effects in same building caused by street-car running over a crossing near-by.
Fig. 3. Vertical vibrations of same building, showing effects caused by heavy wagon in street.
Fig. 4. Motor-generator substation. Vibrations of floor. (The large vibrations of the lower line are compression waves from a passing street car).
Fig. 5. Six-story brick building. Transverse vibrations. Taken on roof.
Fig. 6. Six-story brick building. Longitudinal vibrations. Taken on roof.
Fig. 7. Six-story brick building. Vertical vibration of concrete basement floor, showing effects due to street-car.
Fig. 8. Ferry-building tower. Transverse vibration.
Fig. 9. Ferry-building tower. Typical longitudinal vibration.
Fig. 10. Ferry-building tower. Vertical vibrations of seventh floor.
Fig. 11. Ferry-building tower. Continuous 48-hr. run, showing tilting due to temperature effect, and absence of tidal tilting.
Fig. 12. Eight-story concrete building. Horizontal transverse vibrations of rear wing. (Shows beats due to superposition of two frequencies).
Fig. 13. Claus Spreckels building. Vertical vibrations of 19th floor due to elevators.
Fig. 14. Same building. Elevator vibrations taken at higher speed of record drum and greater lever multiplication.
Fig. 15. Same building. Horizontal vibrations at right angles to Market St. (Upper line, fundamental period, 2.32 sec. Middle line, first odd harmonic. Lower line, second odd harmonic).
Fig. 16. Same building. Horizontal vibrations parallel to Market St. (Period of fundamental, 1.97 sec.).

Fig. 13 shows the vertical vibrations, taken with the speed of the recording drum one-fourth revolution per minute. The larger vibrations are produced by the stopping and starting of elevators. Fig. 14 shows the vibrations produced by the stopping of an elevator; the speed of the recording drum was about one revolution per minute, and the magnification was slightly greater than in Fig. 13. The frequency of the vibrations is 7 per sec., and their maximum double amplitude 0.04 mm.

Fig. 15 shows the vibrations perpendicular to Market St. The first line gives the fundamental, the second line the first odd harmonic, i.e., period approximately one-third the fundamental, and the third line the second odd harmonic. Elsewhere on the records, vibrations of period one-seventh of the fundamental are clearly distinguished, while analysis at some places yields the harmonic whose vibration period is one-ninth the fundamental. These harmonics enter with varying phases and intensities and yield a great variety of curves. The period of the fundamental is 2.32 sec. Typical double amplitudes are: fundamental 0.08 mm.; vibrating in thirds, 0.032 mm.; vibrating in fifths, 0.02 mm.; vibrating in sevenths, 0.01 mm. Minute tremors are always present, of frequency 14 per sec., due doubtless to running machinery.

Parallel to Market St. the vibrations seem by preference to consist of the fundamental and second odd harmonic. The first odd harmonic is not readily distinguishable, although the third one is frequently found. The period of the fundamental is 1.97 sec. Typical double amplitudes are: fundamental 0.07 mm.; period one-fifth fundamental 0.02 mm. Fig. 16 is typical of these vibrations. Minute tremors sometimes enter with a frequency as high as 20 per sec.

A 12-hr. run, from 6 p.m. to 6 a.m., taken at slow speed, showed clearly how the vibrations decrease as the traffic grows less, and during the small hours of the night become minute, the double amplitude being about 0.005 mm. The wind velocity during the night was four to six miles an hour.

The records thus far taken were all made when very little wind was blowing, and represent vibrations produced by street traffic and by the legitimate use of the building. Street traffic does not merely send tremors through a building; it sets the building in vibration in the building's own natural period. That the Claus Spreckels Bldg. should vibrate in the odd harmonics, like a steel rod clamped at one end, and this even when the amplitude of the fundamental vibration is less than 0.1 mm., is strong testimony to the rigidity of its steel frame.

The frequency of tremors obtained, transmitted through the ground and pavements, varied from 4 to 21 per sec., the more common frequencies ranging from 6 to 9. Probably the number 21 marks the approximate upper limit of sensibility of the recorder for the minute amplitude concerned.

General Remarks

When traffic is heavy and the building under study is vibrating almost continuously, it is practically impossible to pick out the exact cause of a definite vibration. The problem is further complicated by the distance to which the tremors are transmitted through the ground. At those times when there is little traffic, the definite cause of a particular result can often be located. In general where the source was at a distance the disturbance was recognized only as a tremor, but occasionally a building started to rock when there was no traffic in the adjacent streets. A heavy truck or street car at a crossing half a block away has been definitely found in some cases to set a building rocking. Street traffic seems to produce more effect in rocking buildings in that portion of the city along the bay front, which is built on made ground.

A regular disturbance, such as that by a motor-generator, may produce a tremor of greater amplitude in an adjacent brick building than in the concrete building in which the generator is placed. The number of paths (such as partitions) by which the tremors can be transmitted, the nature of the foundation of the generator, etc., are, of course, entering factors; but, given a train of waves of definite energy, as these waves enter a medium of less elasticity or of less density the amplitude must increase in order to take up the energy. The amount lost by reflection is apparently not enough to compensate for this needed increase in amplitude in the particular case in question.

The frequency as well as the amplitude must be considered in determining from its magnitude whether or not a particular vibration will be felt. For a frequency of 7 per sec. a double amplitude of 0.03 to 0.04 can be felt, while for a frequency of 2 the double amplitude must be greater, approximately 0.1 mm.

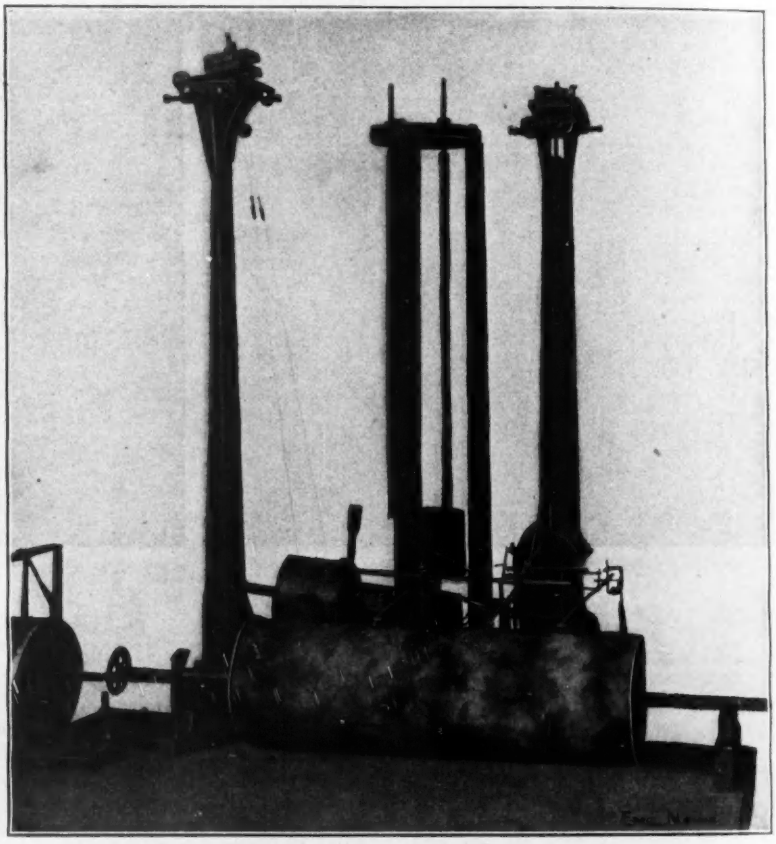


Fig. 17. Prof. Hall's Vibration Recorder; Cover Removed

The Instrument

Fig. 17 shows the recorder with which the above results were obtained, with the cover removed. The instrument is similar to standard seismographs of modern type. All the working parts are adjustable, so that the machine may be put easily and quickly in adjustment. The suspended body for each of the three components has a mass of 25 lb. The

base and standards are of rigid cast-iron construction. The construction of the conical pendulums is such as to allow a great variety of adjustments. The distance of the masses from the standards may be varied, the head of the standard being capable of adjustment so that it may be set perpendicular to the suspension wires for any desired angle. The length of the boom may also be varied by means of sleeves. The range of magnification is therefore large, being from 10 to 110 for the horizontal components, and from 15 to 80 for the vertical component. The magnification is determined in accordance with the theory of the seismograph as given by Prof. Reid.*

The period of vibration of the conical pendulums may, of course, be varied at will; in the work described above it was from 6 to 8 sec. The period of the vertical component is fixed and is 1.2 sec. Damping is obtained by vanes dipping in oil, and may be adjusted. The damping in the records described above was such as to render the pendulums almost aperiodic.

It was found necessary in the construction of the machine not only to have as little solid friction as possible, but also to have the writing levers as light as possible. In the case of minute rapid vibrations, if the inertia factor becomes important, the elasticity of the material takes care of the vibrations and they do not appear at the writing point. The writing levers are therefore not balanced; they are made of aluminum strip, rolled to a thickness of No. 40 B. & S. gage, and have an inverted U-shaped groove down the center to give rigidity in the vertical plane.

The recording device, mounted on a separate base from that of the machine proper, consists of a rotating drum driven by clockwork. The mechanism is such as to give the drum lateral motion as well as motion of rotation. The three components are recorded simultaneously. The drum is 6 in. in diameter by 20 in. wide, and a record of vibrations corresponding to about 20 revolutions of the drum may be taken on one sheet of paper. The rate of rotation may be varied from several revolutions per minute to one revolution in 36 hours. By the use of an idler, the paper being stretched betwen idler and drum, a strip of paper 4 to 8 ft. long may be used, in which case a record covering 75 or 80 revolutions of the drum may be obtained; the lateral motion, of course, is very much less when the idler is used. As the driving clock, in which the escapement has been replaced by a vane governor, will not run quite uniformly, a time clock is used. A cam in place of the second hand of the time clock (or in place of the minute hand for very slow rotation of the drum) works a lever which makes a mark on the paper at regular intervals. This gives intervals of time from which frequencies can be calculated, and also aids in the identification of a particular disturbance, if the time of the disturbance be known.

*Report of California Earthquake Commission, Vol. 2, p. 145.

A Method of Proportioning Concrete

The new "Specifications for Concrete and Concrete Materials and Mortar and Mortar Materials," recently issued by the U. S. Navy Department, as noted in the news columns of this issue, contains an interesting method of proportioning concrete, indicated in the following extract as "Method B":

METHOD A.

(Fixed volumes of sand and stone.)

(*a*) **Mass concrete** (1:3:6).—Foundations for buildings, including wall foundations, column piers, curtain walls, retaining walls in earth, abutments, wall footings, concrete foundations, and mass concrete similar to these shall be composed of one part cement (allowing 100 lb. to the cu.ft.), three parts by volume of sand, and six parts by volume of broken stone or gravel.

(*b*) **Reinforced concrete** (1:2:4) in columns, beams, slabs, walls, etc., shall be composed of one part cement (allowing 100 lb. to the cu.ft.), two parts by volume of sand, and four parts by volume of broken stone or gravel.

METHOD B.

(Fixed volume of stone and variable volume of sand.)

(*c*) **Proportions of concrete** under Method B, which is to be used only when specially required by the specifications for the work, shall be as follows:

Class A.—One part cement (allowing 100 lb. to the cu.ft.) to six and one-half parts by volume of broken stone combined with a variable proportion of sand.

Class B.—One part cement (allowing 100 lb. to the cu.ft.) to four and one-fourth parts by volume of broken stone combined with a variable proportion of sand.

(*a*) **Determining amount of sand.**—It is the intention with the given amounts of cement and broken stone to secure concrete as dense as possible. The amount of sand to be added will therefore depend on the actual character of the sand and broken stone, and the number of cubic feet of sand to be added will be determined by frequent experiments and tests of the material as actually delivered and accepted during the progress of the work. The proportion will be established from time to time for each class of aggregate used and will not be changed during any period of 24 hours, unless the contractor desires to use materials of different characteristics, and the proportion determined at any one time shall continue to be used until the next determination is made and the contractor has been ordered to change the previous proportions.

(*e*) **Tests for amount of sand** shall be conducted as follows: To a fixed volume (not less than 5 cu.ft.) of dry stone, which shall be a representative sample, add a fixed volume of dry sand. Mix these very thoroughly, so as to fill all the voids as uniformly as possible, and then measure and weigh the resulting mixture. Repeat the experiment with varying amounts of sand. That proportion of sand which gives the heaviest mixture per unit of volume shall be used in preparing the concrete. The labor and materials for the experiments shall be furnished by the contractor, but the experiment shall be conducted under immediate supervision of the officer in charge.

(*f*) **Run of crusher stone.**—The specifications elsewhere require the screening out of particles of broken stone and gravel below ¼-in. in size. Under "Method B" of proportioning materials, this will not be necessary if it can be shown by tests that the amount of fine material remaining in the stone or gravel is such that with the addition of sand the resulting total of fine material below ¼in. size will be at least equal to the most suitable grades of natural sand. Tests must be made to determine that there is not an excess of fine material beyond that required to give the densest possible aggregate. Permission to use run of crusher stone as described in this paragraph must be previously obtained from the officer in charge of the work.

An Interesting Comment on American extravagance is found in the following item from "The Engineer," London:

The Swiss Federal Railways Administration has decided to place on its first- and second-class carriages movable plates indicating the number of the class instead of painting the numerals as at present. The reason for this step is to enable the guard to convert a first-class into a second-class coach when the latter is overcrowded by the simple expedient of changing the number plates. So far as comfort is concerned there is little difference between the first- and second-class compartments, and as almost the only holders of first-class tickets are said to be English and American travelers, it is thought that the innovation may be the first step in the eventual abolition of the first-class on the Swiss railways.

A Systematic Fight against Malaria has been waged on the Adriatic lines of the Italian railways since 1899, according to an article in the June, 1912, issue of the "Rivista Tecnica delle Ferrovie Italiane." The campaign was started in 1899 immediately after the discovery of the part that the anopheles mosquito plays in malaria and was carried on until 1905 by the private company operating the road and from 1905 to date has been carried on by the government, which now controls the railway. The work comprises preventive measures in the way of drainage and petroleum distribution over ponds, all supervised by an extensive sanitary staff which inspects the whole line. In addition, the employees along the line are under strict medical supervision and no small part of the work has consisted in the proper distribution of quinine to these men. From 1905 to 1911 the government has spent about $200,000 in the work, but the results have been decidedly worth the money. In the period from 1885 to 1890 it is stated that the number of railway employees seized with fever on these lines comprised 87% of the total number of employees residing in the dangerous zone, which included about 700 miles of road. During the year 1911, out of 22,520 employees living under the same conditions, but operating some 2000 miles of road the number of persons stricken with fever was only 13.3% of the total.

Repairing Washouts on a French Railway

Repairing washouts on a railway line which follows the bank of a river subject to floods is a class of work which has to be provided for by the Paris & Orleans Ry., of France, and some very extensive work of this kind was carried out during the winter of 1910-11. This is described in the *Revue Generale des Chemins de Fer* for January, 1912, by Mr. Liebeaux, Chief Engineer of Maintenance of Way of the railway mentioned. From this paper we have prepared the following description, which is of particular interest at this time when so much work of a similar character has been made necessary by the severe floods through the Mississippi River valley. One feature of the foreign work to which special attention may be called is the general use of portable railway track and light equipment for emergency work of this kind.

The line from Tours to Nantes follows the valley of the River Loire and at several points it is directly along the river bank, the railway embankment serving as a levee to hold back flood water, but also tending to back up the water of streams and freshets flowing across the valley to the river. This is a very undesirable condition for a railway, especially as the clay with which the levee is built makes it difficult to maintain the tracks, while a break in time of flood may have very serious effects upon the railway. Every year, generally in the spring, there is at least one heavy flood in the river. Warning is always given as soon as the water reaches the 5.5-meter mark on the gage at the bridge at Ingrandes, and a special service of inspection and protection is then maintained day and night. Tugs are stationed at dangerous points, and material trains are held in readiness, loaded with rip-rap, brush fascines and sand bags.

The year 1910 was unusually rainy, and during the autumn the water in the river remained at an exceptionally high level. Early in November, the continuous rains caused the first of a series of floods, the water very soon reaching the danger point on the gage, so that the precautionary service noted above had to be put in operation. This flood subsided, but the water rose again and by Nov. 30 it had reached the 6-meter mark and was still rising. In the afternoon, it was reported that at some points the water was encroaching upon the tracks and had covered the rails; trains were still running, though at reduced speed. During the night the water continued to rise rapidly, and about 1 a.m. the first breach was made in the embankment. This was followed by others. At some points, the floods of tributary streams, checked by the embankment, flowed across it, washing away the ballast and cutting trenches 3 to 5 ft. deep in the bank, the core of which still stood, with the drainage water on one side and the river on the other. It was seen that about 52,000 cu.yd. of material would be required to close the four great breaches or crevasses between Verades and Ancenis, but it was not then possible to get trains to these points. On Dec. 5, 1910, a temporary subsidence was caused by the rupture of a levee on the opposite side of the river, and the energetic staff then succeeded in repairing the tracks so that by Dec. 10 preparations could be made for the work of closing the four crevasses.

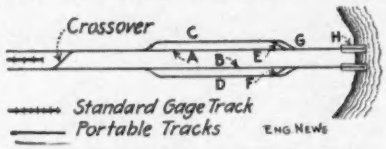


FIG. 1. PLAN OF PORTABLE RAILWAY TRACKS AND DUMPING PLATFORMS FOR CLOSING CREVASSES NOS. 1 AND 2 IN AN EMBANKMENT BY WORKING FROM THE ENDS; PARIS & ORLEANS RY. (FRANCE)

CLOSING THE END CREVASSES

To get quick results in checking the widening of the crevasses, which increased continually, it had been proposed at first to attack all at once, and to hold the ends of the banks as soon as possible by means of rip-rap deposited by barges. Unfortunately the height of the flood prevented boats from passing the bridges, and as the rains continued the flood maintained its level. It was only possible, therefore, to attack the two extreme crevasses and each of these from one end only. One plan was to build across the breach a levee of reduced size, having the top only a little above the flood level and with a width of about 13 ft., or just sufficient for a single track. On account of the current, these banks could be made only of stone and heavy material. When once completed, the trains could be run to the other two crevasses, while at the same time large quantities of material could be dumped to widen the narrow banks across the first two crevasses. For rapid filling of a bank from the end, however, the ordinary standard-gage cars were not suitable, as they could only be dumped laterally. It was estimated that by using the Decauville portable track of 24-in. gage, with side-dump cars of 1⅓ yd. capacity and dumping platforms, it would be easy to dump 65 cu.yd. per hour or at least 650 yd. per day. The layout planned for this work is shown in Fig. 1. Here the two inner tracks *A* and *B* are for loaded cars, and the two outer tracks *C* and *D* are for empty cars. The spurs *E* and *F* are for the engines handling cars at the dump. Thus, with an engine at *E*, five loaded cars would be pushed (assisted by gravity) from *A* until they cleared the switch. The engine at *E* would then run out, back the cars to the dump *H*, bring them back to *G* and return to *E*, leaving the cars to be pushed through the turnout to the empty-car track *C*. The dumping platforms projected over the edge of the gap, each being supported by guys from a gallows frame at the shore end.

The next thing was to insure a supply of 650 cu.yd. per day, and it was found that stone quarries in operation within reasonable distance could furnish only 200 to 325 yd. for each point. Slate quarries and steel works which were accessible had large stocks of slate refuse and slag, but to take only the large pieces would have involved a tedious and costly sorting, and both plants combined could not furnish more than 78 to 130 yd. of sorted material daily. It was necessary then to open new quarries, but under the conditions it was a difficult matter to get more than a small output promptly. Finally, it was found possible to procure for each point of attack a total of 650 yd. of block stone and coarse material, but it was very difficult to exceed this.

To widen the first narrow bank thus formed to close the breach from the end, so as to restore the embankment to its full normal cross-section, was a much easier matter. With large side-dump cars of standard gage, dumping along a frontage of 350 ft. at each breach, and with large sources of supply from the slate and steel works, the main problem was that of transportation. The operating department furnished an ample supply of cars for the use of the maintenance-of-way department and arranged to handle them in 60-car trains on the regular tracks to the station nearest to each breach. Fig. 2 shows the arrangement of tracks at each point. The large cars were run on an unloading track from which the contents could be delivered by chutes to barges or shoveled into the narrow-gage dump cars for transfer to the work on the breach.

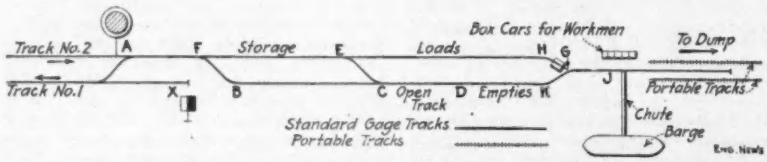


FIG. 2. PLAN OF STANDARD-GAGE TRACKS AT THE YARD FOR DELIVERING MATERIAL TO THE PORTABLE RAILWAY EQUIPMENT

To insure safety it was arranged that track No. 2 (Fig. 2) would be used for the inbound and outbound construction trains, track No. 1 being cut temporarily at *X*, opposite the distant signal. Beyond this point track No. 2 was (much higher than the ordinary price, of course) should be the same at all points, in order to avoid competition, piecework and strikes. A program was drawn up also for carrying on the work, and this we summarize below.

and dividing the work into sections. The layout of the yards was commenced Dec. 10, and the first of the three sections of the work, as noted above, was completed by Dec. 14 at one place and Dec. 20 at the other.

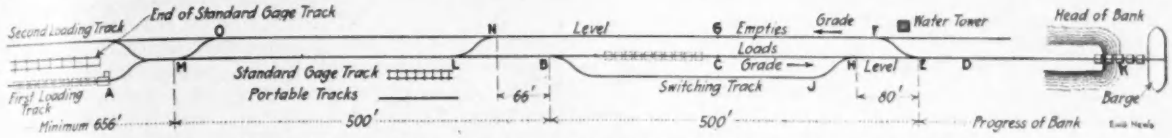


FIG. 3. PLAN OF PORTABLE RAILWAY TRACKS FOR CLOSING CREVASSE NO. 3

doubled, and the trains were operated on the siding, leaving the straight track for the storage of loaded cars held in reserve in case of any delay in the production or transportation of material. Under these arrangements, a locomotive, arriving with a 60-car train at the end of the operated line *A*, was pulled through the turnout to the track *B-D*, and then backed through the crossover *C-E* onto the storage track *E-F*; the engine then returned through the crossover and ran to the point *D*, where it was coupled to a train of empty cars on *D-K* which it took back over *B-C* to *A* for return to the quarry. Thus the stretch of track *C-D* was kept always free for train movements; it had a length of 1640 ft., to accommodate 60-car trains. The switching engine at *G* shifted the loaded cars as needed from *F-E* to *E-H*, and also (as needed) to the stub track *J*, for unloading into barges or the small dump cars. The empty cars on this track were pushed back through the turnout to the empty-car track *K-D*, until a regular 60-ton train was on this track. With these arrangements, the traffic capacity was in excess of all requirements. All movements between the station and the yard were made under protection of the pilot system, no train being allowed to move unless the pilotman was on the engine. Consequently, there was no fear of collisions. In addition, some covered cars were set out on an isolated piece of track to provide for feeding and sheltering the workmen.

In carrying out these arrangements under emergency conditions it was necessary to divide the work, some building the embankments, others getting out stone, opening quarries or loading material at the slate and steel works. Local facilities were utilized as far as possible, and contracts let to the few contractors who had the necessary material ready for immediate work. Fortunately, the road has a general contractor for maintenance work, Julien Duvat, who could put onto the work several hundred men well trained and equipped. Regulations were laid down as to the methods of measuring and paying for the materials and work; for the laborers, time cards were issued daily (under proper check), and it was provided that the price per hour

1. PRELIMINARY—Lay out the yard; put in the crossover *C-E* and establish the dead-end *X*. Place the portable tracks and the chutes for barges, and assemble the barges. Install a water tank and provide covered cars for shelter, provisions and hospital aid. Concentrate all loaded cars on the tracks specified. Keep track *C-D* always free. Supply engines for the trains. Designate the points of production and loading, and state the probable production from each point.

2. CLOSING THE CREVASSE — Load barges, and unload them at the breach, or sink them in the gap. Deposit 650 cu.yd. per day. Arrange day and night gangs. Provide switching engine for the yard and engines for handling trains at the stations. Arrange for regular movement (as frequent as possible) of loaded trains and return of empty cars on the main line.

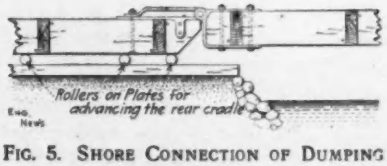


FIG. 5. SHORE CONNECTION OF DUMPING PLATFORM

3. COMPLETING THE WORK — Extend the standard-gage stub-track *J*, and the portable tracks as the work advances. Widen the bank as soon as it has crossed the breach, using an additional engine

WORK AT CREVASSE NO. 3

For closing one of the two crevasses between the end ones already described, somewhat different methods were adopted by the contractor, Andre Perdriel. Instead of four portable tracks and two suspended dumping platforms (as in Fig. 1), there were only three tracks and a single dumping platform supported by a barge. The arrangement of the tracks is shown in Fig. 3. Two Decauville locomotives were used, one handling the small dump cars to and from the dumping point and the other switching the loaded and empty cars on the yard tracks. By this system five-car trains were dumped at an average interval of five minutes, equivalent to 65 yd. per hour. The outer end of the dumping platform (projecting over the water) was not guyed from an overhead frame (as in the first case Fig. 1), but was supported on a barge, as shown in Figs. 3 and 4. As the height of the barge varied with the load, the dumping platform was connected by a hinge at its rear end to a sliding frame supporting the track, as shown in Fig. 5. When the fill was completed as far as the barge, the barge, platform and frame (or cradle) were drawn forward together by a cable operated by a windlass on the barge and anchored on the opposite side of the crevasse. This crevasse was 263 ft. long and was closed in five days (Dec. 15-20),

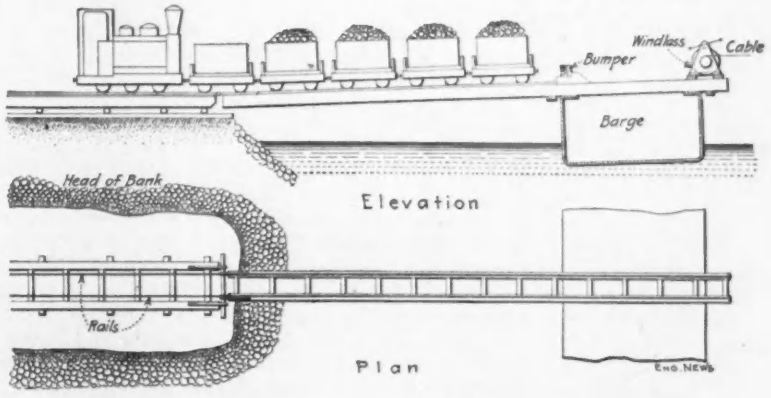


FIG. 4. DUMPING PLATFORM FOR CLOSING CREVASSES IN A LEVEE

(Portable railway of 24-in. gage and 1½-yd. dump cars.)

The first fill to cross it was about 16 ft. high at the middle, with a width of 12 ft. on top and 42 ft. at the bottom, with slopes of 45°. From Dec. 20 to 24, the height and base were increased about 3 ft. by side dumping, and on Dec. 25 the standard-gage tracks were laid across it so that material trains could be run to the next crevasse.

In the plan of the portable railway equipment at crevasse No. 3 (Fig. 3), the engine *A*, at the left, took a train of ten dump cars from the loading track to the position *B-C;* it then ran to *D*, returned through the crossover *E-F*, and pushed a train of empty cars from *G* back to the loading track. Two men at *C* uncoupled five cars and pushed them (down an assisting grade) from *C* to *H*, the cars coming to rest on the level stretch *H-E*. An engine stationed at *J* then pushed the five-car train to the unloading bridge *K*. When the cars were dumped this engine hauled them back as far as *D*, and then ran to its position at *J*. From *D* to *G* the cars ran by gravity on an assisting grade.

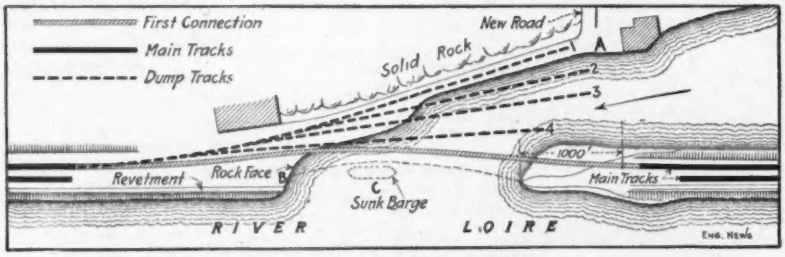


FIG. 6. PLAN SHOWING METHOD OF CLOSING A CREVASSE IN SPITE OF A SWIFT CURRENT, BY SUCCESSIVE STAGES OF SIDE DUMPING ON A DIAGONAL LINE

The tracks *L-M* and *N-O* provided ample storage for loaded dump cars to insure continuous work during the handling of empty and loaded main-line trains at the yard and unloading tracks (beyond the left of the plan, Fig. 3).

WORK AT CREVASSE NO. 4

The difficulties were specially great at this point, where the flood water in an old channel of the river burst the bank. The depth of water was considerable, and there was a very strong current running from the flooded land side into the river. One end had been eaten away steadily by the water, but by Dec. 13 stone-filled barges had been sunk and held this side against further erosion. It was not practicable to carry on the work by end dumping, as in the other cases, for the current was strong enough to carry away large blocks of stone. At the other side of the crevasse, there was solid rock, and an outcrop of rock extended from *A* to *B*, Fig. 6. A sunken barge *C* formed a stop for any fill that might be thrown in from this end. The plan adopted was to attempt a diagonal closing, working from the end *B* and along the line *B-A*. It was thought that if a complete closure could not be made, the gap could be reduced sufficiently to enable a light bridge to be thrown across for the use of the portable railway, so that material could be transported to the next breach. There was no fear of raising the water level on the land side of the bank, as there were numerous drainage openings and bridges to permit the flood water to escape to the river.

After repairing the roads, which the rain and floods had transformed into sloughs, and building a new road across the fields to a main highway, material was brought in by wagons for a track extending from the main line in the direction *B-A*. By the time this was done, crevasse No. 3 had been closed, so that standard-gage equipment could be run to this new scene of action. The lateral filling then progressed steadily, the successive positions of the construction track being shown by the dotted lines 1 to 4. One main track was extended as the bank lengthened, and on Jan. 3, 1911, this track was connected across the break, allowing an engine to bring to Ancenis a train which had been held at Varades since Nov. 30. The amount of material dumped on the last six days of December was about 5500 yd., ranging from 700 to 1200 yd. per day.

OTHER WORK

Near Anetz, the embankment was badly washed but not broken, and one track remained, able to carry light cars. Rip-rap and piles of ties were laid as a temporary expedient until the bank was made safe for engines and ordinary cars, after which the bank was widened and both tracks were relaid. At another breach, the filling was done by means of a locomotive crane at one side, and a portable railway on the opposite side, the latter being installed on two barges.

BARGE WORK—About Dec. 10, the rupture of a bank on the opposite side of the river caused a lowering of the flood level which enabled the fleet of stone barges to pass under the bridges, so that tugs could take them to the crevasses. They were used more particularly at crevasse No. 4, work at which is described above.

TOTAL WORK—In all the work, the total amount of material deposited was about 70,000 cu.yd., and the total cost was $240,000 or $3.43 per cu.yd.

Switching Locomotives with Improved Valve Gears

While many improvements have been introduced upon locomotives in ordinary road service, comparatively few changes have been made in switching engines. This is due in part to the fact that the humble but useful switch engine is considered of too lowly a character to warrant putting on refinements, while the rough service and hard usage of yard shifting render it doubtful whether such improvements would show real advantage or economy, as in the case of road engines. For instance, the application of a valve-gear designed to effect an economy in steam consumption might be of little practical value, since the way in which the engine is worked (with a consequent succession of stops, starts and short runs) would militate against any material saving. And if the new gear involved any special complication of parts it might have to be unduly heavy to stand the severe conditions of service without excessive wear and maintenance. On the other hand, it is quite possible that the efficiency of a switch engine might be improved by the application of valve-gear which would give a quicker distribution of steam than the ordinary gear, and thus make the engine more responsive to the continual shifting of the lever; provided, of course, that the gear will maintain its efficiency under conditions of rough usage.

In view of the conditions noted above it is not surprising that switching engines are still generally equipped with the old reliable Stephenson valve-gear, although this gear has strong competitors for use on road engines. But other gears are being introduced even on engines of the former class, and we illustrate herewith two applications of this sort. These include the Baker-Pilliod gear and the Walschaerts gear. In both of these the mechanism is outside of the frames, thus making the parts readily accessible, eliminating all axle fittings, and leaving the interior space free for ample cross bracing between the frames.

BAKER-PILLIOD VALVE-GEAR. (C. & N. W. Ry.)— In Fig. 1 is shown the arrangement of the Baker-Pilliod valve-gear as applied to 30 switching engines of the Chicago & Northwestern Ry., and the general features of this gear were described in our issue of May 4, 1905. A view of one of the engines is given in Fig. 2. At first 15 engines were equipped in order to try this gear in service, and the results were such as to lead to an order for 15 more engines fitted with the new gear. It is considered that these engines are giving better results than those equipped with the Stephenson gear, although no tests have been made as yet to determine definitely what is the actual economy.

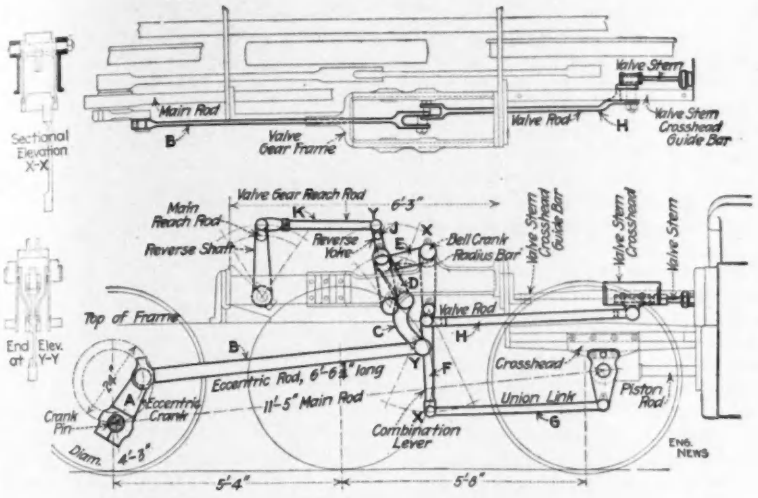


FIG. 1. BAKER-PILLIOD VALVE GEAR APPLIED TO SWITCHING ENGINES; CHICAGO & NORTHWESTERN RY.

SWITCHING ENGINES (0:6:0) WITH BAKER-PILLOID VALVE GEAR, CHICAGO & NORTHWESTERN RY.

Driving wheels (6)	4 ft. 3 in.
Wheelbase, engine	11 ft. 0 in.
Engine and tender	41 ft. 10 in.
Weight in working order	130,500 lb.
Tender	110,600 lb.
Cylinders	18x24 in.
Valve gear	Baker-Pilliod
Valves, piston, diameter	11 in.
Valves, travel	6¾ in.
Eccentric crank, length	15¼ in.
Lap, 1 in. lead	¼ in.
Exhaust clearance	⅛ in.
Boiler, diameter	5 ft.
Working pressure	180 lb.
Firebox	82x38 in.
Tubes, No. 203, diameter	2 in.
Length	11 ft. 10 in.
Heating surface, tubes	1248.9 sq.ft.
Firebox	130.6 sq.ft.
Arch tubes	10.4 sq.ft.
Total	1389.9 sq.ft.
Grate area	21.8 sq.ft.
Water in tender tank	5500 gal.
Coal in tender	8 tons
Maximum tractive power	23,330 lb.

It will be noted that in these engines the rear wheels are the main drivers, thus getting a longer connecting-rod than in the usual arrangement of attaching the connecting-rod to the middle drivers. From the eccentric crank *A* (carried on the main crankpin), the eccentric rod *B* leads to a vertical connecting-rod *C*, and radius bar *D*; this is connected to the shorter arm of a bell-crank lever *E*, whose longer arm carries a combination lever, *F*. The lower end of this lever is connected to the crosshead by the union link *G*, and near its upper end is the attachment of the valve rod *H*. For reversing and adjusting the position of the gear, the bell-crank lever is attached to a yoke *J*, which revolves on a fixed center and is operated from the main reverse shaft by means of an intermediate reach-rod *K*. It will be seen that the movement of the valve rod is effected by the combined motions of the eccentric crank and the crosshead. The fixed bearings of the gear are carried in a cast-steel beam above the frame.

The Baker-Pilliod valve-gear has been used also on some six-wheel switching engines of the Erie. In this case it was adopted partly because of its inherent advantages, and partly because the rear wheels were made the main drivers. With this arrangement it was impracticable to use the Stephenson gear with eccentrics on the middle axle when the connecting-rods were on the rear axle. The accompanying table gives some particulars and valve-gear details of the engines of the Chicago & Northwestern Ry. (Figs. 1 and 2). Two special advantages claimed for this gear are: 1, that it is very easy to operate (requiring little exertion of power on the reversing lever), and, 2, that it has no shifting bearings, as in the link and block of the Stephenson and Walschaerts gears.

WALSCHAERTS VALVE GEAR. (Pennsylvania R.R.)—In Fig. 3 is shown a six-wheel switching engine of the Pennsylvania R.R. which is fitted with the Walschaerts valve-gear. In this case the middle wheels are the main drivers, so that the connecting-rods are very much shorter than those of the engines described above. In this gear, the return crank *A* (on the main crankpin), is connected by a rod *B*, to a bent arm *C*; whose upper end is slotted and forms a rocking link *D*. The valve rod *E* has a block fitted to this slot, and the rod (with its block) is raised and lowered by the hanger *F* attached to the bell-crank lever of the reversing gear. The forward end of the valve rod is attached to the upper end of the suspension lever *G*, the lower end of which is connected to the crosshead by a short rod *H*. The valve stem *J* is connected to the suspension lever, and its motion is derived from a combination of the movements of the eccentric crank and the crosshead. The action of the gear is varied, of course, by shifting the point of attachment of the valve rod, *E*, to the rocking link, *D*.

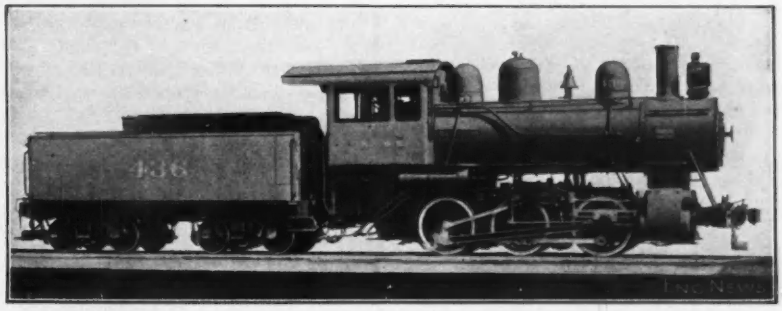


FIG. 2. SWITCHING LOCOMOTIVE WITH BAKER-PILLIOD VALVE GEAR; CHICAGO & NORTHWESTERN RY.

These engines have cylinders 22x24 in. and driving wheels 4 ft. 8 in. diameter, with a wheelbase of 11 ft. 6 in. This gear is now used on switching engines by several railways.

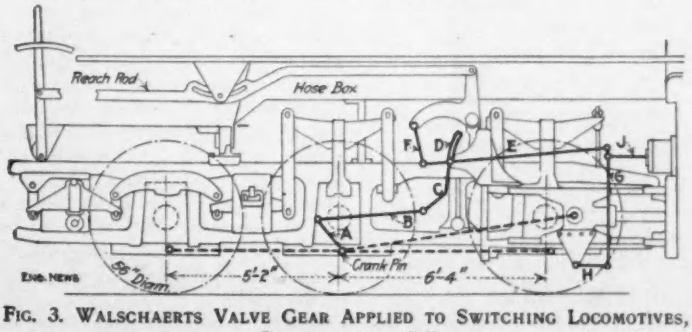


FIG. 3. WALSCHAERTS VALVE GEAR APPLIED TO SWITCHING LOCOMOTIVES, PENNSYLVANIA R.R.

The Municipal Housekeeping of Moose Jaw, Saskatchewan

The enterprising city of Moose Jaw, in western Canada, is trying an interesting experiment in city government. In direct contrast with the commission plan, with its concentration of all executive and legislative powers in a single commission, Moose Jaw retains its city council as the supreme municipal authority, but entrusts executive duties to three city commissioners. These include the mayor (*ex-officio*), an engineer and a man trained in business and finance. The mayor is paid $2000 a year. He does not give his entire time to the city, but meets with the commissioners every day for consultation. The engineer member of the commission receives $6000 a year and the third member $3000 a year. The city council refers various questions to the commission for investigation and report, but is not legally bound by the advice of the commission. The commission, which is itself appointed by the council, makes appointments to other executive positions, constructs public improvements and operates the various municipal undertakings. (The by-law creating the commission and defining its powers and duties is printed at the end of this article.)

It will be seen that there is here a partial separation of legislative and executive functions, but that the legislative body appoints and is superior to the executive body, which includes the mayor. The choice of a business man and an engineer to serve as commissioners is a recognition of the fact that in its executive department city government is a matter of business and of engineering administration. How fully the city council will recognize this by following the recommendations of the commissioners remains to be seen.

Perhaps the most unique feature of the Moose Jaw city government, as now practiced, is its recognition of the value of the trained engineer as an executive officer and the relatively large, but none too large, salary paid to the engineer-commissioner. It is also interesting to note that (after advertising for applicants for the position) an engineer from the United States was chosen—L. W. Rundlett, for twenty years and until recently city engineer of St. Paul, Minn.

Moose Jaw now has a population of about 22,000 (1558 in 1901 and 20,263 in 1911), many substantial and architecturally fine buildings, and at least the usual public improvements in a new town of its size. It has a number of problems incident to local conditions, some of which may be briefly noted.

The Water Supply

First, mention may be made of the water supply. This presents difficulties because of the small rainfall (only 10 in.), and the lack of nearby sources of suitable quality and quantity. The Moose Jaw River flows through the town, but it is turbid whenever there is a good volume of flow and quite inadequate in quantity through a large part of the year. A partial supply is drawn from a filter gallery near the river and some water is brought in from springs about eight miles distant. About half a million dollars is being expended for an additional supply, which it is hoped will be available in August, 1912. About 2,000,000 Imp. gal., it is hoped, will be developed by a filter gallery 4000 ft. long, on Sandy Creek, and about 1,000,000 Imp. gal. from wells which will be sunk to a depth of 90 to 100 ft. Some or all of the new supply will be pumped 50 ft., flow 20 miles by gravity to the city, then be repumped. Besides this, a special high-pressure fire-protection supply, drawn from the river at the city is proposed.

The provincial or the Dominion government will probably make surveys to determine the practicability of bringing water to Moose Jaw and other municipalities from the Saskatchewan River, 70 miles distant.

Sewerage and Sewage Purification

Sewage disposal is also a problem, owing to the small flow of the Moose Jaw River the greater part of the year. The following description of the sewerage and sewage-disposal system has been supplied by Mr. Rundlett:

The sewer system of Moose Jaw consists of a separate sanitary sewer system and a storm-water system. When the system was first designed, sewage passed through a small septic tank discharging into the Moose Jaw Creek. With the growth of the city, however, a larger tank, with a capacity of 135,000 Imp. gal. per 24 hours, was designed, discharging into the creek about one-fourth mile east of the old tank. This latter tank was connected with the existing system by an 18-in. vitrified-tile sewer. The continued growth of the city and the new public-health act adopted by the Province have necessitated the installation of an up-to-date sewage-disposal works, which consists of a screening chamber, stand-by tanks, separator tanks, and percolating filters and a final settling tank. The effluent from the filters is further treated by disinfection where necessary, more especially during time of epidemic, so that the final effluent that is discharged into the creek will be of a non-putrescible nature, and harmless to either fish, stock or persons. Sludge in the sewage will be treated on filter beds and, when dry, burned in the incinerator, which has been erected adjacent to the disposal works.

Screen House—All large, heavy solids are retained by the screen.

Stand-by Tanks—There are two covered stand-by or equalizing tanks, built of reinforced concrete, each 122 ft. long and 6½ ft. deep, of 95,000 Imp. gal. capacity each.

Pump House—This is 30 ft. by 20 ft. in plan. It contains two (but provision is made for future additions) compressed-air ejectors which raise the sewage from the stand-by tanks to the separator tanks.

Separator Tanks—These are three in number, each being approximately 24 ft. x 60 ft. x 7 ft. deep, or of 62,500 Imp. gal. capacity. The sludge here settles and is carried away by underlying drains to sludge beds.

Sludge Beds—There are two sludge beds, each 50 ft. x 35 ft. x 3 ft. deep. Eventually sludge will be burned in the refuse destructor, located nearby.

Percolating Filters — The effluent from the separator tanks passes to 26 filter beds, each being approximately 70 ft. x 14 ft. x 8 ft. deep. The effluent is distributed over the filter beds by means of Stoddard trays. The filtering medium is broken stone, with underdrains which collect the effluent.

Disinfecting Chamber—The effluent from the filters is carried to a chamber where disinfecting liquid will be added as occasion may demand.

Settling Pond—From the disinfecting chamber the effluent passes to a large settling basin, 225 ft. x 125 ft. x 3 ft. deep, from which it eventually passes to the creek.

General—Each filter unit is estimated to be capable of handling about 43,300 Imp. gal. of effluent per day, making a total of about 1,125,000 Imp. gal. per day, which will provide for a population of about 37,000 persons. The entire plant is designed on the unit system, which will permit units to be added as necessity demands. The substructures are all built of reinforced concrete. The superstructures are of framework, covered with corrugated galvanized sheet iron.

The total cost of the plant as at present designed is about $134,251; $125,000 being for construction of the works and the extension of the present sewer system to the plant and $9251 for special machinery and equipment.

Collection and Disposal of Night Soil

On streets not yet provided with sewers the city has established a system of night-soil collection. This system, together with the refuse destructor, which will also burn night soil, is described as follows in notes submitted by the health officer of Moose Jaw, through Mr. Rundlett:

Night-soil collection is not intended to take the place of the more sanitary water closet where sewers are provided, but to supersede the surface closet in those dis-

tricts still outside the limits of the sewerage system. The closets are constructed without the usual trap door at the back and the seat is hinged, with a compartment underneath large enough to admit the pail. A hinged flap renders the closet practically flytight.

The pails are made of galvanized iron, with a capacity of about 2⅓ cu.ft., and with taper sides to allow for nesting in transport and to resist expansion due to the action of frost in winter. Several sample pails were made. The one adopted has sides of 24-gage metal, with a bottom of 20 gage pressed out of one piece and a rim reaching 4 in. up the side, to which it is riveted and soldered. This makes it exceptionally strong. The weight of each pail is 17 lb. To insure uniformity and a suitable article, the pails are obtained by the city in large quantities, under contract, and cost only $3.05 delivered in the city. The owner is charged the cost price of the new pail, maintenance and renewal to be borne by the city.

About every ten days the pails are changed. The staff for this work consists of two men for each district, with a steel tip wagon into which the pails are emptied, and a light lorry on which are stacked the clean pails to be exchanged for the soiled ones as the route is worked. Thus at each time of change the house is provided with a clean pail and all filth is completely removed from the premises. The excreta have been disposed of by mixing with ordinary garbage and stable manure at the nuisance ground and by burning, but in the future it will be similarly destroyed at the incinerator. The soiled pails are thoroughly cleansed by hose with hot water from the incinerator boiler and are ready for use the next night.

TYPHOID PAILS—Another branch of the pail system, and one that is applicable to the whole of the district, was introduced last season. This is a special sanitary pail with a close-fitting splashtight cover for use at houses where typhoid patients are being nursed. These are painted a distinctive color and are changed twice weekly. When sent out they contain a strong liquid disinfectant and are intended for the reception of the discharges or other infected substances coming from the sick person. The contents of these are destroyed also by fire.

REFUSE DESTRUCTOR

Other house refuse or garbage is collected during the day in covered vehicles and disposed of in a similar manner at the destructor.

The destructor is a recent addition to the sanitary equipment of the city, being only at the present moment (June 20, 1912) going into commission. It was erected by Messrs. Heenan & Froude, of Manchester, England. It has a capacity for dealing with 40 to 50 tons of refuse per day of 24 hours and is of the three-cell continuous type. It is fitted with a hot-blast forced draft, the incoming air being heated to a temperature of over 500 F. A 250-hp. boiler is also part of the equipment whereby the heat from the burning refuse is to be utilized. Its cost will be about $46,000.

OTHER IMPROVEMENTS

All told, the city has laid some three miles of creosoted wood-block pavement and four blocks of asphalt. Asphalt macadam has been considered, but the clayey soil does not afford a good natural foundation for macadam road and there is no local stone available for crushing, although gravel can be had for concrete.

The city owns an electric-lighting plant which, Mr. Rundlett states, has been more than self-supporting. It was partly destroyed by a fire in May, 1912. When rebuilt, which will be right away, it will be modern in every respect and will have cost the city about $215,000.

Present indications are that for some years to come the city council and city commissioners of Moose Jaw will have a busy time trying to make municipal improvements keep pace with growth in population and its attendant municipal needs. As the problems to be met and solved will be largely engineering in character, it is fortunate that the city council took pains to secure an experienced engineer-commissioner and associated with him and with the mayor an able business man to conduct the executive work of the city. If the Moose Jaw authorities, unlike the cities of the United States, and some Canadian cities as well, keep municipal affairs free from baneful politics, a bright municipal future seems assured this city of the Canadian West.

POWERS AND DUTIES OF THE MOOSE JAW COMMISSIONERS

By-law No. 595 of the city of Moose Jaw, providing for Commissioners, is as follows:

A By-law of the City of Moose Jaw to define the powers and duties of the Commissioners of the City of Moose Jaw, appointed pursuant to the Cities Act.

The Council of the City of Moose Jaw enacts as follows: 1. There shall be appointed two Commissioners who shall hold office during the pleasure of the Council, subject, however, to dismissal as provided in the Cities Act, and who together with the Mayor shall be called the Commissioners of the City of Moose Jaw. (2) It shall be the duties of the Commissioners of the City of Moose Jaw:

(a) To carry out and enforce all orders, resolutions and by-laws of the City Council, and all reports of Committees as approved of by the Council.

(b) To have general supervision, administration and care of all the Departments of the City, the collection of taxes, of license fees, and of all revenues or moneys payable to the City; the care and management of the Fire Brigade, and other public services, and of all property and works; improvements, roads, streets and public places owned or controlled by the City.

(c) To make a report in writing to the Council during the month of December in each year of the work that has been carried out under their direction during the current year and to submit to the Council at its first meeting in January in each year, recommendations and estimates for expenditures which, in their opinion, should be made by the Council during the then current year.

(d) To approve the purchase of all incidental supplies required by the departments not exceeding the sum of $300 and to prepare specifications for and recommend the awarding of all contracts, and for that purpose to call for all tenders for works, materials and supplies, implements or machinery or any other goods or property required and which may lawfully be purchased by the City, and to report the same to the Council at its next meeting. Upon the opening of any tenders, the Chairman of the Commissioners may require the presence of the head of the Department with which the subject matter of such tender is connected, and of the City Solicitor when necessary. Such head of a Department may take part in any discussion of the Commissioners relating to such tender, but shall not be entitled to vote.

(e) To inspect and report to the Council monthly, or oftener, if and when required by the Council, upon all municipal works being carried on or in progress by the City, and from time to time to report to the Council upon any and all matters referred to them for that purpose by the Council.

(f) To nominate to the Council for approval all heads of Departments and any other officer of the Corporation required to be appointed by By-law or resolution of the Council, save as hereinafter provided, and to recommend the salaries of all officers and clerks.

(g) To dismiss or suspend any head of a Department and forthwith to report such dismissal or suspension to the Council with the reasons therefor save as hereinafter provided.

(h) To attend all meetings of the Council, and, when required so to do, the meetings of the various Committees in an advisory capacity.

(i) To approve all accounts before the same are submitted to their respective Committees.

3. The Commissioners shall jointly or separately perform such other duties and shall have such other powers as shall be specified from time to time by By-law or Resolution of the Council, and the Council may by By-law or Resolution alter such duties and powers from time to time.

4. The Commissioners so appointed shall give their whole time and attention to the business of the City. They shall attend at their office in the City Hall between the hours of ten and eleven o'clock in the forenoon on all days except Sundays and Statutory holidays unless and until same shall be altered by resolution of the Council, and shall hold such other meetings as may be necessary or fixed by By-law or Resolution of the Council.

This By-law shall not apply to the office of City Solicitor, City Auditor or Police Department, but without restricting the generality thereof, shall include the City Clerk, the City Engineer, City Treasurer, the City Assessor, the Electrical Superintendent, the Medical Health Officer, the Inspector of Licenses, the Health and Food Inspector and the Fire Chief.

DONE AND PASSED in Open Council this eighth day of January, A. D. 1912.

(Sgd.) ALFRED W. MAYBERY,
Mayor.
W. F. HEAL,
City Clerk.

The Influence of Poisson's Ratio on Stresses in Arch Dams

By Lars Jorgensen*

In calculating the stresses in an arch dam it is necessary to find the proportions of the load taken by arch action and by cantilever action, respectively. But it is also important to determine how much of the load is taken by the arch due to initial stresses in the structure, since only after deducting this part of the load does the remainder divide between arch and cantilever action in the ordinary sense. The subject of initial stresses in arch dams has not been much discussed as yet. It is very important in dam design, however, and should be taken into consideration when trying to find the actual division of load between arch and cantilever.

When a dam is completed the lower layers of the dam body are in compression due to the weight of material above. When a body is compressed the dimension in the direction of the compressive force becomes smaller; in all other directions the body swells if free to move (lateral strain). The ratio of lateral to longitudinal strain is known to lie between 1:3 and 1:4 for bodies equally elastic in all directions, such as metals, but for concrete, which is not a very homogeneous substance, this ratio is about 1:5, or 0.2, at the unit-compression generally used in arch-dam design. University of Illinois Bulletin No. 20, by Prof. A. N. Talbot, gives values for Poisson's ratio $\left(\frac{1}{m}\right)$ from 0.1 to 0.18 at low loads, and up to 0.25 at loads near the ultimate, for 1:2:4 concrete 60 days old. The French Commission on reinforced concrete found Poisson's ratio for ordinary concrete to be about 0.16 when a force of 200 lb. per sq.in. was applied perpendicular to the largest dimension of the concrete, and about 0.22 when applied at right angles to the largest dimension.

Prof. C. Bach made some tests recently at the laboratory of the Stuttgart (Germany) technical college, on 1:2:3 concrete 45 days old, and found for Poisson's ratio the value $\frac{1}{5.3}$, or 0.1885, at a unit compression of about 180 lb. per sq.in. This value is especially interesting because it was found indirectly, by comparison of the results of compression tests and shear tests. The unit deformation under compression (B), and that under shear (d) were found separately, and substituted in the formula*

$$m = \frac{2}{\frac{B}{d} - 2}$$

which gave $m = 5.3$. This indirect method is thought to give results nearer the truth than the direct method, especially at lower loads, as the lateral expansion at these loads is so small that it is difficult to measure accurately.

For use in dam calculation it would seem to be justifiable to use $\frac{1}{m} = 0.2$, as the dam body generally contains large stones. The presence of the stones should increase the value of Poisson's ratio to 0.2 for the total mass.

At the bottom of a dam the mean pressure, in height of masonry, upon the foundation is equal to the area of the cross-section divided by the bottom thickness of the section. The bottom layer of material will receive a compression corresponding to this height of masonry and it will, therefore, have a tendency to become longer in all the horizontal directions. If the abutments are unyielding the arch may be prevented from actually becoming longer at the bottom, in which event axial compression is introduced the same as if water pressure acted upon the structure. By means of the above ratio the value of the axial compression can be found, and from that the height of water in the reservoir which would hold this initial stress in equilibrium.

The initial axial compression due to the weight of the masonry is equal to one-fifth of the average vertical pressure, if the abutments are unyielding (and so far as the final result is concerned it makes no difference whether they are absolutely unyielding or not). If the specific gravity of the masonry is 2.3 and the height of the dam H, then the average vertical pressure can be expressed as $\frac{2.3H}{a}$ where a is the ratio of total height of dam to height of a rectangular dam having the same sectional area and the same base. The equivalent height a is known as soon as the section is known, and in dam design the section must be more or less determined before final calculations can be made.

The section shown in Fig. 1 has an area of 9668 sq.ft. and a base of 70 ft. Then $\frac{9668}{70} = 138$ ft. is the height of the masonry column causing the mean vertical pressure. As the total height of the dam is 250 ft., a is equal to $\frac{250}{138}$, or 1.81. The average vertical compression upon the foundation becomes $\frac{2.3H}{1.81} = 1.27H$.

With reservoir full the radial water pressure tends to compress the dam body in a direction perpendicular to the direction of the compressive force due to the weight of the body. At the bottom of the dam this force is equal to H in case the water is standing to the crest of the dam. In this case it tends to counteract the swelling of the concrete (due to the weight) in an upstream and downstream direction, and introduces additional axial compression due to the tendency of the body to become longer in all other directions than that of the compressive force.

H. Ballet, a French engineer, who probably was the first to point out this method of calculating stresses near the foundation, stresses which so far have been neglected, adds the vertical and radial pressure in order to find the total pressure causing the initial compression. (*Proceedings* of the Institution of Civil Engineers, Vol. CLXXVIII, 1909.) The two pressures are perpendicular to each other, and the radial pressure on the upstream face is not directly opposed by any force from the downstream side; therefore opinions may differ as to whether the whole radial pressure should be included in such a calculation. However, if the ratio between the swelling and the shortening for concrete is taken as ⅕ the result should be on the safe side, even with the whole radial pressure added to the vertical pressure. On this basis the total initial stress is

$$\tfrac{1}{5}\ (1.27\ H + H) = 0.454\ H$$

The height of water that this initial stress will resist without causing any shortening of the length of the arch at the bottom is, therefore, equal to

$$0.454\ H\ \frac{t}{R_u} \qquad (1)$$

For the narrower section shown in Fig. 1, $t = 70$ ft. at the base, and the upstream radius at the base, R_u, is 75 ft. Substituting these values it is seen that this section at the very bottom is able to take up $(0.454 \times H \times \frac{70}{75} = 0.425\ H)$, or 42.5% of the total water pressure acting as an arch before any shortening in the length of the arch occurs. The remaining 57.5% of the load will be divided between cantilever and arch action in the usual way.

By analyzing Eq. (1) it is easily seen how the designer may make the arch take more or less of the load by utilizing the initial stresses, by varying t or R_u. If in Fig. 1 the base thickness is increased from 70 ft. to 110 ft., and correspond-

*Engineer with F. G. Baum & Co., Chronicle Bldg., San Francisco, Calif.

*The proof of this formula can be found in Bach's "Elastizität und Festigkeit," 5th ed., p. 301, or 6th ed., p. 298.

ingly at higher elevations, and R_u is kept at 75 (this is as short as the upstream radius can be made for practical reasons), then the initial stresses will be able to support at the foundation $0.4\ H\ \frac{110}{75} = 0.585\ H$, or 58.5% of the total load before any shortening in the length of the arch occurs and before any additional stresses are introduced. When the valley at the site of the dam is narrow near the bottom, this additional thickness does not increase the volume of the dam body very much, and therefore might be warranted.

equal to $0.41\ H\ \frac{160}{324} = 0.20\ H$, or 20%. Comparing this with 58.5% or 42.2% for the new type of dam, it is easily seen that the constant-angle arch is much more effective in utilizing the initial stresses to support the load than an ordinary arch having a single center.

If a gravity section is insisted upon for the arch and the method of constructing the upstream face previously described is employed, it will be possible for the gravity section to take up the greatest part of the load acting as an arch. The result is not a cheaper dam,

In Fig. 2 are shown at the left the deflection curves for the section of Fig. 1, having base length of 110 ft., and for the ordinary arch-dam section, Fig. 2, designed for the same site. The assumption has been made in computing these deflections that the arch takes all the load. The curves show how evenly the deflection decreases from a maximum at or near the top to nearly nothing at the bottom in the constant-angle type and how little this decrease amounts to in the ordinary type. They show very plainly that from the old arch type we cannot expect much arch action toward the bot-

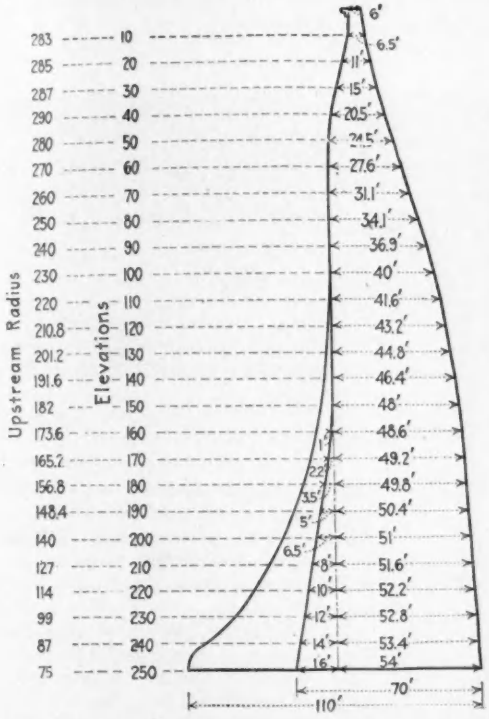


FIG. 1. ARCH DAM SECTIONS OF CONSTANT-ANGLE TYPE, FOR 250-FT. HEIGHT

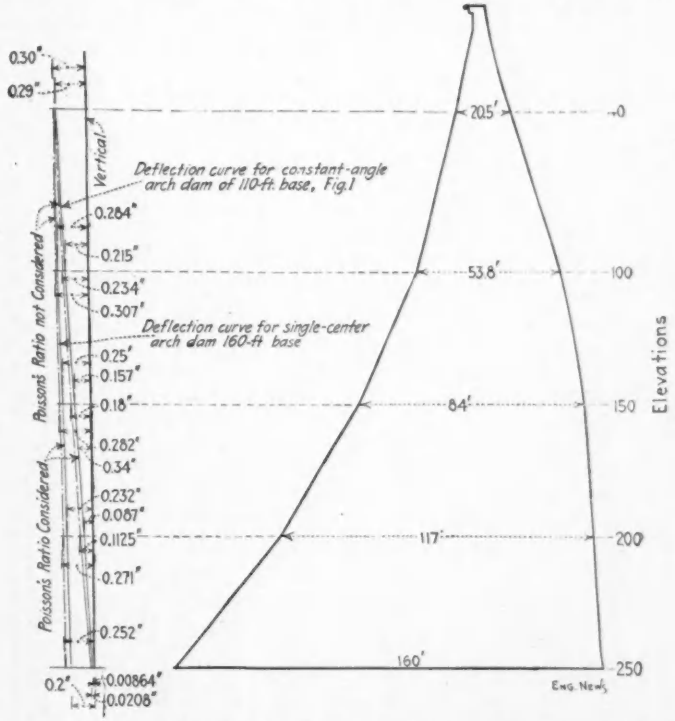


FIG. 2. ARCH DAM SECTION OF SINGLE-CENTER TYPE, FOR SAME SITE AS FIG. 1, WITH COMPARATIVE ARCH-DEFLECTION CURVES

The dam whose section is represented in Fig. 1 was designed with varying radii, to keep the central angle of the arch as nearly constant as possible for all heights.* For comparison a section is shown in Fig. 2 using the same upstream face batter and the same unit compression, but a single common center, as in the usual construction, which causes the upstream radius to increase toward the bottom (in this case to 324 ft.). For this section the average vertical compression on the foundation is $\frac{2.3}{2.2}\ H = 1.04\ H$ at the base, and the corresponding total initial axial compression due to the lateral deformation is $\frac{1}{5}\ (1.04\ H + H) = 0.41\ H$. The height of water which this initial stress would resist is, therefore, but the factor-of-safety has been increased several times, with only a slight increase in material due to the smaller average radius employed in the construction of the new type of arch.

It may be argued that shrinkage of the concrete while setting will, to a large extent, compensate for the axial expansion due to the lateral deformation. This is true when the reservoir is empty and the concrete dry, but this condition is not of nearly so much interest or importance as that of reservoir full, for which condition it is not true. In this latter case the concrete is water-soaked, and in that state the length of the arch is at least equal to the original length before setting.*

tom; cantilever action must take the load at the bottom, since no such deflection as 0.2 in. could be possible at the point where the arch is fastened to the rock foundation. The constant-angle arch type, requiring only 0.00864 in. deflection (23 times less) to support the same load, would take most of the load upon it acting as an arch; this small deflection would be within the elasticity of the material, and only a minor portion of the total load would have to be taken up by cantilever action.

*See the writer's article "Arch Dam Design: The Constant-Angle Type of Arch Dam," Eng. News, July 25, 1912, p. 155.

*That concrete expands either enough or more than enough to compensate for shrinkage due to setting, when kept wet, has been fully demonstrated, as by the tests reported by A. T. Goldbeck and by A. H. White at the 1911 convention of the American Society for Testing Materials, Eng. News, July 6, 1911, p. 26.

The First Efficiency Engineer was not one of those who have been so much in the public eye of late, for the calling is a very old one. One of the first American efficiency experts was the many-sided Benjamin Franklin. Among his rules for attaining perfection in the 13 virtues is the following: "Lose no time; be always employed in something useful; cut off all unnecessary actions."

The High Pressure Fire Service System in Baltimore, Md.

The high-pressure fire-service system of Baltimore was put into service on Apr. 23, 1912, although the pumping-station equipment has not yet been formally accepted by the city. The Baltimore system differs from that of New York City in having steam-driven reciprocating pumps instead of motor-driven turbine pumps. Another interesting feature of some novelty is the unusual type of hydrants adopted. The hydrants themselves are of a specially designed flush type provided with manhole covers that are flush with the sidewalk. Portable hydrant heads with four connections for hose lines are carried by the firemen. The separate head permits the use of regulator valves permanently attached, one for each of the four hose lines, which gives excellent control of the pressure in the different lines, and it is claimed that the time required for getting into action at fires is not materially increased. The use of the flush hydrants, however, has necessitated the adoption of a special system of inspection and a special method for familiarizing the firemen with the location of hydrants.

A special report by the National Board of Fire Underwriters' committee on fire prevention, issued under date of June 29, contains detailed information on the organization, equipment and tests of this system, from which the following account has been prepared.

The pumping station, as shown on the accompanying map, Fig. 1, is located in the southeastern part of the congested-value district of the city on the west side of South St. north of Pratt St. and extends west from South St. to an alley at the rear. On each side of the pumping station are four-story mercantile buildings with blank walls extending from 10 to 20 ft. above the station roof. The pumping station is of fireproof construction throughout, except for floor surfacing and inside doors in the third story. Its roof, which is surfaced with tar and gravel, has been designed to withstand the probable failure of the adjoining overhead walls.

The main pumps are of the crank-and-flywheel type designed to deliver 7000 gal. per min. against 260 lb. per sq.in. pressure at a speed of 87½ r.p.m. They are of the horizontal twin simple non-condensing class with Corliss valve gear. The steam cylinders have a diameter of 22 in. and the water plunger diameter is 13⅜ in., while the stroke is 36 in. Three of these units are provided, giving a total rated capacity for the plant of 21,000 gal. per min. Besides the main units there is a smaller one of the duplex compound direct-acting type which is used for maintaining a pressure of 150 lb. on the system when the main pumps are not in service. Steam is supplied by a battery of three Edge Moor watertube boilers with underfeed mechanical stokers.

At the station 150 lb. steam pressure is maintained on two of the boilers at all times and 150 lb. water pressure is kept on the distributing system by the direct-acting pump. Upon receipt of an alarm from the high-pressure area, steam is turned on to two of the large pumps and the water pressure is raised almost immediately to 250 lb. The direct-acting pump stops when the water pressure exceeds 150 lb. The larger pumps are provided with speed governors and have steam valves controlled by pressure regulators actuated by the water pressure in the distribution system. Thus with the throttle valves on the main pumps opened, their operation is automatic, and since the mechanical stokers and forced draft of the boilers are automatically controlled by the steam consumption, the station can be run for some hours, if necessary, without any attention.

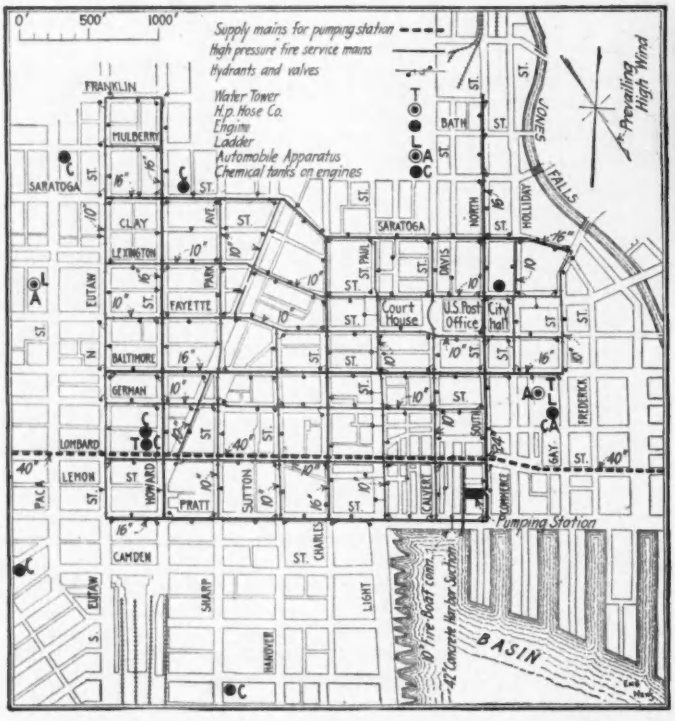


FIG. 1. MAP OF THE DISTRIBUTION SYSTEM, BALTIMORE HIGH-PRESSURE FIRE SERVICE

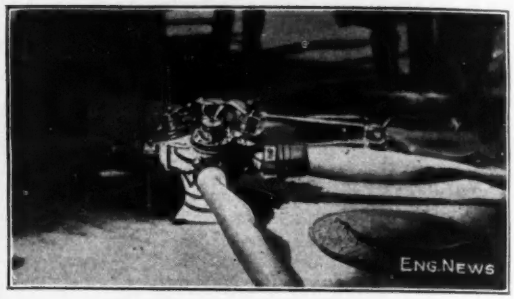


FIG. 2. ONE OF THE PORTABLE HYDRANT HEADS SHOWN ATTACHED TO HYDRANT

The distribution system, as shown in Fig. 1, covers an area bounded by Pratt, Eutaw, Franklin, Howard, Saratoga, Day, Baltimore, and South Sts. The boundary line of the high-pressure area, which extends about 400 ft. outside of the border line hydrants, includes an area of some 170 acres. The general plan followed provides 16-in. mains three blocks apart in both directions, with 10-in. lines on all other streets. The mains are divided into sections by 259 steel gate valves located generally on the property lines, four valves at each street intersection. Thus, in most cases any single side of a block may be cut out of service without interfering with the rest of the system. The average length of pipes between valves is 300 ft.

All the pipe is lap-welded soft open-hearth steel designed for a maximum working pressure of 300 lb. per sq.in. The 8-, 10- and 16-in. pipes are $\frac{7}{16}$ in. thick and the 24-in. pipe is ½-in. thick. The standard length is 20 ft. The pipe lines, including valves, hydrants and other fittings were tested and made tight at a pressure of 600 lb. per sq.in. before back-filling. A 500-ft. length of the 10-in. pipe in a test witnessed by engineers of

the National Board of Fire Underwriters in 1910 withstood a pressure of 1000 lb. without failure and without any leakage except at the gaskets of the valve bodies.

With the idea of avoiding electrolysis the pipe joints have been specially designed for the placing of metal to metal without the use of any gasket or filler so as to make the electrical conductivity of the joint approximately equal to that of the pipe body. These joints are made by means of a connecting ring whose external surface is the zone of a sphere. These rings fit into the expanded ends of the pipe lengths. The joint is tightened up by means of bolts and outside steel flanges.

Relief valves are located at various points in the system and set to open and waste into the sewers at a pressure of 305 lb. Air valves are provided at all summits.

One of the specially designed flush hydrants is shown in Fig. 2 with its sidewalk cover removed and the portable service head attached ready for use. The heads can be locked into position by a slight turn. Each hydrant head has four 2½-in. outlets and each outlet has its own regulating valve so designed as to serve also as a shutoff valve. A fifth outlet in the top of the hydrant head can be used for connecting a monitor nozzle. The hydrants themselves have 10-in. barrels with 8-in. branch connections to the mains. Each hydrant was subjected to a hydrostatic test pressure of 600 lb. per sq.in. The total number of hydrants on the present system is 226, the average linear spacing being 170 ft., and the area served by each hydrant about 42,700 sq.ft. Markers are being placed on trolley feeder poles and other convenient points to indicate the locations of the hydrants so that they can be more easily found by the firemen.

The portable hydrant heads are carried on the hose wagons of the two newly established high-pressure fire companies and by the hose wagons of ten of the old engine companies in the district. All of these companies also carry special turret nozzles to be attached to the outlet on the top of the hydrant head. Upon arrival of the hose wagons at the scene of the fire, two men carrying the hydrant head and key run to the hydrant. One man removes the manhole cover and the other places the head in position and locks it to the top of the hydrant by giving it a slight turn. Water is turned on with the hydrant key and the hose is attached to one or all of the outlets. By means of the regulating valves on the head, any desired pressure can be given each line individually up to the full pressure in the mains without the necessity of communicating with the pumping station.

Since the system has been placed in service it has been tried out at three serious fires and the results obtained with the flush hydrants were quite satisfactory. Tests which have been made of the time required to attach one of the portable hydrant heads has shown that two men starting from the middle of the street could remove the hydrant cover, place the head in position and turn on the water in from 18 to 25 seconds. Tests for friction loss in the hydrant head indicated a loss in the outlet and the regulator valve equivalent to about 10 lb. for a flow of 300 gal. per min. from a single outlet, 20 lb. for 500 gal. per min. and 25 lb. for 600 gal. These losses are not considered excessive. Screens were originally provided in the hydrant heads to catch coarse material, but tests showed that these screens became clogged and introduced a very high friction loss, amounting to 30 lb. for a flow of 2300 gal. per min. The committee on Fire Prevention considers that these screens are not necessary to the operation of the hydrant and recommends their removal.

The Comparative Strength of the Chief Naval Powers

At the present time the British House of Commons is debating on proposed appropriations to expand its warship building program to outdo the latest move of Germany. Winston Churchill, First Lord of the Admiralty, proposes to increase the program from three vessels next year, four in 1914, three in 1915, four in 1916 and three in 1917, to five vessels in 1913 and four vessels each year thereafter till 1917. This will give 33 new battleships for England to 29 in the German program. In supporting Mr. Churchill's proposal, Arthur Balfour said: "The cost of the navy must increase so long as insane competition in shipbuilding goes on elsewhere; and, though modern peace is as expensive as ancient war, it is cheaper than modern war."

The accompanying Table I gives the strength of the various navies at the beginning of the present year as compiled by the U. S. Navy Department. Table II gives the personnel of these navies. During the last three years these eight nations have spent approximately $2,000,000,000 in naval expenditures alone, *to keep peace among themselves.*

TABLE I. COMPARATIVE STRENGTHS OF THE WORLD'S NAVIES (1) VESSELS BUILT; (2) VESSELS BUILDING OR AUTHORIZED

	Battleships, Dreadnought type (*a*)		Battleships, (*b*)		Armored cruisers, Invincible type (*c*)		Armored cruisers		Cruisers (*d*)		Destroyers		Torpedo boats		Submarines		Coast defense vessels (*e*)
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	
England (*f*)	12	10	42	0	5	5(*k*)	34	0	79(*k*)	10(*k*)	192(*k*)	31(*k*)	59	0	65	17(*k*)	0
Germany (*g*)	7	9	21	0	2	3	9	0	39	6	109	12	22	0	14	10(*i*)	5
United States	6	6	25	0	0	0	12	0	30	1	36	14	28	0	20	18	4
France	0	4	20	0	0	0	22	0	10	0	72	13	200	0	66	15	2
Japan (*h*)	0	3	13	0	2	4	11	0	15	3	58	2	59	0	10	3	2
Russia	0	7	9	0	0	0	6	0	11	0	95	13	29	0	31	8	2
Italy	0	4	8	0	0	0	10	0	6	3	22	10	46	46	9	11	0
Austria	0	4	6	0	0	0	3	0	6	3	14	6	43	12	6	6	6

(*a*) Battleships having a main battery of all big guns (11 inches or more in caliber).
(*b*) Battleships, 1st class, are those of (about) 10,000 tons or more displacement.
(*c*) Armored cruisers having guns of largest caliber in main battery and capable of taking their place in line of battle with the battleships. They have an increase of speed at the expense of carrying fewer guns in main battery, and a decrease in armor protection; also called battleship cruisers.
(*d*) Includes all unarmored cruising vessels above 1,000 tons displacement.
(*e*) Includes smaller battleships and monitors. No more vessels of this class are being proposed or built by the great powers.
(*f*) England has no continuing shipbuilding policy, but usually lays down each year 5 armored ships with a proportional number of smaller vessels.
(*g*) Germany has a continuing shipbuilding program, governed by a fleet law authorized by the Reichstag. For 1912 there are authorized 1 battleship, 1 armored cruiser, 2 cruisers, 12 destroyers. Eventual strength to consist of 38 battleships, 20 armored cruisers, 38 cruisers, 144 destroyers.
(*h*) $78,837,591 authorized to be expended from 1911 to 1917 for the construction of war vessels.
(*i*) $3,570,000 authorized for experiments and further construction.
(*k*) Includes vessels of colonies.

TABLE II. PERSONNEL OF THE WORLD'S NAVIES

Rank	England	France	Germany	Japan	United States
Admirals of the Fleet	4	.....	2	1	(*)
Admirals	12	.....	5	7	.....
Vice Admirals	22	15	12	20	.....
Rear Admirals	55	30	22	38	30
Captains and Commanders	636	340	302	296	212
Other line officers	2,274	1,509	1,596	1,710	1,114
Midshipmen at sea	506	61	398	154	287
Engineer officers	940	505	433	696	.....
Medical officers	593	413(*b*)	286	358(*c*)	348
Pay officers	697	216	236	324	202
Chaplains	138	.....	.....	.....	24
Warrant officers	2,494	2,350(*c*)	2,512	1,520	645
Enlisted men	105,434	53,316	50,389	42,043	47,500
Marine officers	425	.....	109	.....	334
Enlisted men (Marines)	19,635(*a*)	.....	4,672(*d*)	.....	9,521
Total	133,965	58,755	60,974	47,167	60,217

*The Admiral of the Navy.
(*a*) Includes 3,100 men of the Coast Guard.
(*b*) Includes pharmacists and apothecaries.
(*c*) Includes adjutants, premier maitres, and maitres of all branches.
(*d*) Marine infantry and seaman artillery.
(*e*) Includes pharmaceutical officers.

City Extension in Relation to the Planning of Street Railway Systems

The relief of the crowded condition of cities by extending their areas and providing living accommodation and rapid-transit facilities for the outskirts is one of the important steps in municipal development in Europe. This problem was the subject of a paper presented before the International Union of Tramways and Light Railways, at Brussels (Belgium), by Mr. Wattman, of the Municipal Street Railways of Cologne (Germany). From

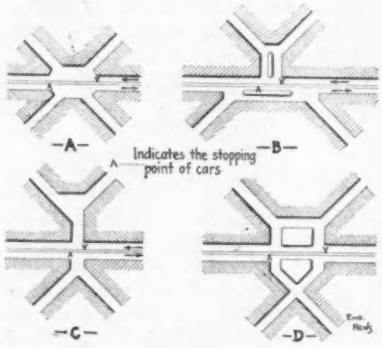


FIG. 1. PLANS OF STREET INTERSECTIONS ON STREETS HAVING CAR TRACKS

this paper we have taken the information which is presented below in condensed form.

In solving the problem of city extension and improved housing accommodation, the electric railway is a most important factor. It has already almost revolutionized local transportation, due to the speed, frequency and cheapness of its service. Observations in different cities indicate that in general the street-railway passengers represent from 20 to 50% of the total circulation; and the proportion may become much higher when (as at Cologne) the local movement or circulation is small as compared with that between the city and its suburban districts. Since a distribution of the population in small buildings on a large area (instead of its concentration in crowded tenements and tenement districts) is demanded by economists, sanitary and medical experts, and architects, the speed of service on the street-railway lines is a most important factor in securing the desired distribution. Elevated and underground railways are left out of consideration, as they are practicable only for very large cities.

The higher the speed the greater will be the service radius, or the practicable distance between the city and the suburbs. It might be supposed that under these conditions, the municipalities and the street-railway authorities would have worked together to provide the best locations and conditions for high-speed service. But unfortunately this has not been the case. Of 73 companies, 70% stated that they had no influence and were never consulted on the subject of building or developing new residence districts. On the other hand, the railways have failed to do all they should have done in this direction, for their own interests as well as for those of the municipality.

In laying out a plan for an improvement of this kind, it is desirable in the first instance to lay out in advance the streets which are to be occupied by street-railway lines. These should be the main arteries, and should provide also for pedestrians, cyclists, horsemen, carriages and automobiles. These main lines should be radial; lateral or belt lines being necessary only in districts already built up, and serving to connect the radial lines. It will be necessary to determine also, whether one or several lines are required, but as a rule two lines in the same district should not be less than 2600 ft. apart (with stops at intervals of 1300 ft.); in towns, this may be reduced to 2000 ft., while in districts only partially built up it may be increased beyond 2600 ft. When the spacing comes below 2000 ft., it will usually be better to unite the two lines in one. Circular or circumferential lines (which may or may not be closed on themselves) should be operated independently, as travel on them by cars of the radial lines would increase the time of the journey between the business district and the suburbs.

formed at intervals by several lateral streets running out at various angles. This arrangement of meeting points causes great congestion of traffic at the "star," with a dangerous concentration and crossing of traffic in all directions. At the present time, the tendency is to avoid extremely long vistas of straight streets by introducing angles or bends, but on main arteries this should not be carried so far as to cause an interruption to traffic, though it may be quite admissible for residence streets.

STOPPING POINTS—The spacing of the stopping points for the cars is a direct function of the speed over the line, and where the stops are only 328 ft. apart the actual speed is very low. The loss of time at stops is divided into three parts: (1) deceleration from regular speed, (2) actual stop, (3) acceleration to regular speed. The second item is necessarily very variable. Observations at Cologne showed a minimum of 5 sec. when only one person got on or off; 9 sec. is estimated for two persons and 12 sec. for three persons, with 2 or 3 sec. more for each additional person. The deceleration varies little with the speed, as the braking is much more efficient at the higher speeds; on electric railways this will average 7 to 8 sec. The acceleration gives a loss of time of 16 sec. for 22 miles per hour, reducing to 6 sec. for a speed of 7½ miles per hour. The total loss for stops is summarized as follows, and it is evident that the higher the speed the fewer should be the stops. For

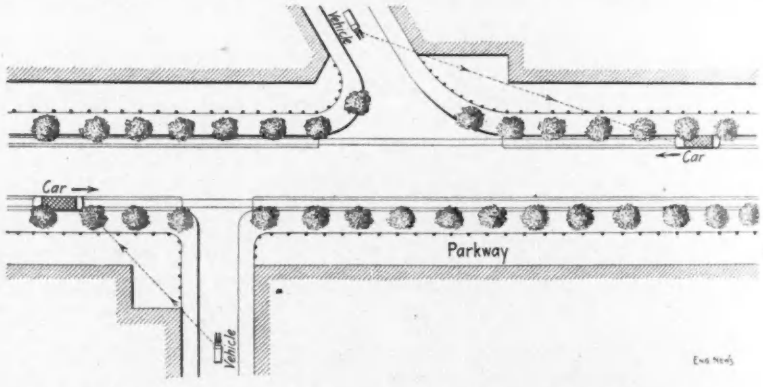


FIG. 2. SPECIAL ARRANGEMENT OF JUNCTION OF A LATERAL STREET WITH A MAIN STREET HAVING CAR TRACKS

The running speed of cars depends largely upon the location of the lines. In narrow streets it may be only 5½ miles per hour (or even 3½ miles per hour), while speeds up to 18 miles per hour are practicable where a special strip is reserved for the tracks. The location should be as direct as possible, not only to save distance and time, but also because curves necessitate reduced speed. Formerly, a common practice in street planning was to lay out long straight lines, with a so called "star" speeds of 7½ to 9½ miles per hour, the stops are usually 1000 to 1150 ft. apart.

Speed, mi. per hr.	Time lost by stop, sec.	Speed, mi. per hr.	Time lost by stop, sec.
22	29	12½	23
19	27	9½	20
15½	25	7½	19

Having determined the spacing and location of the stopping places, it is well to consider the arrangement of streets leading to these points. It will be understood, of course, that these stops are at intervals only, and not at every street in-

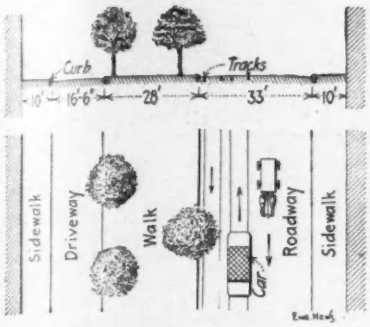


FIG. 3. STREET WITH CENTRAL PROMENADE AND DOUBLE TRACKS IN ONE ROADWAY

tersection; also, that the paper in question deals with European towns having an irregular plan of streets, and not with the uniform rectangular plan common in America. In new districts, the stopping points will represent the objective points of persons going from their residences to the cars; therefore, access to them should be rendered as easy and as short or direct as possible. It is desirable also to make these points secondary centers of the street systems in these districts. To effect this latter purpose it is not necessary to adopt the old "star" plan of

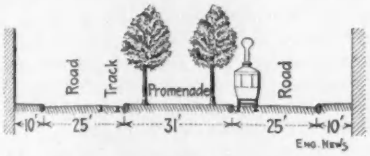


FIG. 4. STREET WITH CENTRAL PROMENADE AND ONE TRACK IN EACH ROADWAY

numerous streets radiating from one point. Fig. 1 shows this arrangement and three alternatives which are superior to it; with the star plan (A), the cars must run at reduced speed across the open space, on account of liability of collision or interference with other vehicles; with the alternatives, collisions are very improbable. The points at which the cars stop in each case are indicated on the plans by dots. Stops should be located at the angle or intersection of main

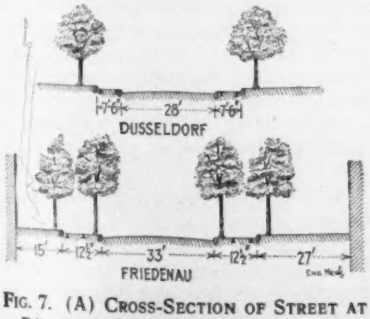


FIG. 7. (A) CROSS-SECTION OF STREET AT DÜSSELDORF; (B) CROSS-SECTION OF THE RHEINSTRASSE AT FRIEDENAU

streets, and centers of traffic circulation should not be established at points where it is impossible to locate stops for the street cars.

To avoid the dangers of street intersections, it is suggested by Mr. Wattman that transverse streets should not be continuous across the main street, but should be offset; the stopping points could then be located clear of the lines of transverse traffic. Fig. 2 shows an arrangement of this kind; it indicates also the line of sight between cars on the main street and vehicles on the side streets. In this case, the buildings are so planned (under direction of municipal authority) as to permit relatively long lines of sight. The cross-section of the main street in this case is that of the upper section in Fig. 7, with a track reservation at each side; it would be still better if the track reservation was in the middle of the street.

On streets where there is much automobile traffic some special provision should be made for the safety of passengers getting on and off the cars. At intersections, a refuge may be placed outside the track at the near side of the crossing, the building line and curb line being made somewhat diagonal at these points to allow of giving the full width of roadway past the refuge. When the tracks are laid on a central reservation, it is well to make this wide enough to leave a narrow walk outside of the cars and available as a refuge. In such an arrangement, the curbs of the track reservation are set at least 5¾ ft. from the center of the track, leaving a clear walk of 26 to 28 in. in width.

When a street-railway line serves places of public attraction (such as parks, pleasure resorts, exhibitions, ball grounds, etc.), provision should be made for terminal operation, so that the direction of the cars can be reversed (by means of cross-overs, etc.) at times when the traffic to or from these points is heavy. It often happens, however, that the local conditions do not permit of proper facilities of this kind, with the result that the efficiency and punctuality of the service are reduced by the delays at these points. In certain cases of this kind, also, it is highly desirable to provide a certain number of sidetracks to hold trail cars in reserve, to be attached to the regular cars when required.

ARRANGEMENT OF TRACKS IN STREETS

For a street having car tracks and permitting wagons to stand at the curb without interfering with the cars, a width of 32.8 to 34.4 ft. is necessary, assuming that this will leave a strip 7 to 7¼ ft. wide for the street railway. In such streets a speed of 9 miles per hour may be attained, while in wider streets it may

FIG. 5. CROSS-SECTION OF THE PRADO AT MARSEILLES
(Three roadways, two promenades and two tracks).

be 11 to 12½ miles per hour. It is desirable to leave on each side of the track a space wide enough for two vehicles to pass, which requires a width of at least 52 ft.; here the speed might be 12½ to 15½ miles per hour, the latter being the maximum on tracks laid in the street proper. For higher speeds, a special part of the street must be isolated for the exclusive use of the tracks; this also reduces the liability of collision with ordinary vehicles and the liability of accident to pedestrians. Side collisions with vehicles running alongside the track are then impossible. With such an arrange-

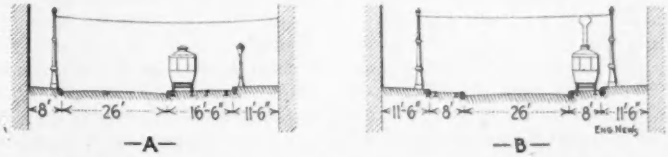


FIG. 6. CROSS-SECTION OF STREETS SHOWING (A) TWO TRACKS AT ONE SIDE OF ROADWAY AND (B) ONE TRACK AT EACH SIDE OF ROADWAY

ment of isolated tracks, the speed may be 18 or even 22 to 25 miles per hour. The part of the street for vehicle traffic may then be reduced by 6½ to 10 ft., for a double track, as the vehicles will not be interfered with by the street cars; this will effect economy in maintenance. The track (except at street crossings) may be of T-rails on ties, which will be less expensive than grooved-rail construction. The track reservation may be paved, or (as at Berlin) covered with grass. The cost of paving this strip should not exceed that of good paving (or asphalt) on the 8¼-ft. width of street which it occupies. The matter of first cost offers very little opening for objection.

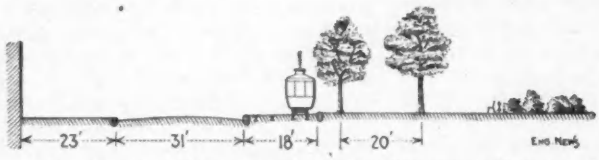


FIG. 8. CROSS-SECTION OF STREET BORDERING PUBLIC SQUARE AT KOENIGSBERG

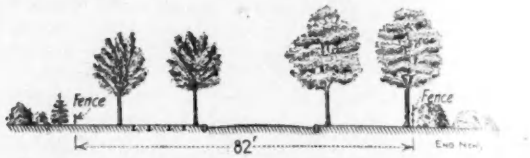


FIG. 9. CROSS-SECTION OF A STREET AT KOENIGSBERG BORDERED ON EACH SIDE WITH A PARK

STREETS WITHOUT SPECIAL STRIP FOR TRACKS—When no special reservation is provided for the track, the arrangement varies according as the street has one or more tracks. With a single track, the best and most usual plan is to place the track in the middle. With two tracks, a very general arrangement is to place a walk in the middle of the street, this being usually bordered with trees and reserved exclusively for pedestrians. The tracks may be placed both on one side of this walk (Fig. 3), or one on each side (Fig. 4); in the former case, access to the cars on the inner track is not convenient, and in the second case, there is no opportunity for cross-over connections. The track should be far enough from the walk to avoid excessive trimming of the trees to clear the trolley wires.

When both tracks are on the same side, the roadway on this side should be about 33 ft. wide, in order to leave sufficient space for two lines of vehicles. When there is one track on each side, a width of 25 ft. is sufficient. Neither of the arrangements shown is entirely satisfactory (that of Fig. 4 being preferable), as in order to reach the cars persons are obliged to cross the entire width of the roadway. In some cases an arrangement with three roadways is employed (Fig. 5); but this is considered defective for the reason that when the total width is sufficient for three roadways it is sufficient also for two roadways and a separate reservation for the tracks. Further, the trees are too close to the tracks.

STREETS WITH SPECIAL STRIP FOR TRACKS—When a special part of the street is reserved for the tracks, the tracks may be placed next to the curbs or in the middle of the street. The latter plan requires a greater width of street, and the former is preferable where it is important to limit this total width. The two arrangements shown in Fig. 6 are both inconvenient, as vehicles from lateral streets (at the right in the first plan) have to cross tracks to reach the roadway; the second plan, however, has the advantage of affording easy access to the cars. Fig. 7 shows this plan as applied to a street in Düsseldorf and to the Rheinstrasse at Friedenau, but in the last named place the trees are much too close to the tracks. The most

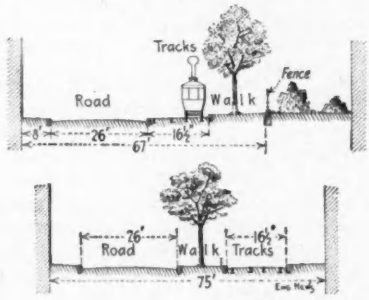


FIG. 10. SECTIONS OF STREETS WITH SPECIAL TRACK RESERVATION AND SINGLE ROADWAY

serious objection to this plan of tracks adjacent to the sidewalks is that drivers of teams approaching on lateral streets have but a limited view of the tracks, so that crossing collisions are liable to occur. This liability can be reduced to some extent by using wide sidewalks and putting parkways or grass strips between the walks and the houses, as the further the tracks are from the houses the wider will be the range of sight from the cross street and the less will be the danger of collisions. The question of cross-overs also must be taken into account.

Placing the tracks next to the walk is advantageous when the street runs along the side of a square or park (Fig. 8), or crosses it (Fig. 9). The inconvenience of a limited view of the track from vehicles approaching laterally does not then obtain, and there is little danger to persons alighting from the cars or unloading goods from wagons. Mr. Wattman attaches little importance to this latter objection, however, as his experience convinces him that the movement of freight, even in a busy street, can be done without danger. Nevertheless, this objection is often made against this particular arrangement of tracks at the sides of streets. The getting on and off of cars becomes very easy when, as in the lower view of Fig. 7, the tracks are placed separately along the two sidewalks. Two other arrangements are shown in Fig. 10.

Arrangements that are much more advantageous are practicable when the tracks are established on a special strip in the middle of the street, with roadways of equal width on each side, though this requires greater total width. Relatively narrow street sections can be secured by using parkways (with turf or flowers) instead of trees along the reservation. Fig. 11 shows this arrangement as adopted for a street in Munich and for the Hardenbergerstrasse in Berlin. It lends itself admirably to the location of stopping points, while at intervals the turfed strip may be modified to form an island of refuge for pedestrians. The esthetic appearance of the street with this arrangement is considered excellent. The appearance is still more attractive when the track strip is bordered with a promenade, as in Fig. 12 (*A*); here the trees are far enough from the tracks, and their distance from the track strip (20 in. beyond the necessary width) is sufficient to clear a person clinging to the side of a moving car. The strip thus formed serves as a platform at stops. The sections (*B*) and (*C*) in Fig. 12 show somewhat similar arrangements; section (*C*) especially provides for very convenient accommodation at stops. Examples of existing arrangements are shown in Fig. 13.

We find this matter of the arrangement of street-railway tracks in a specially reserved part of the street dealt with also in a paper presented at the same convention by Mr. Busse, Chief Engineer of the Great Tramways Co., of Berlin (Germany). He pointed out that both municipalities and corporations are endeavoring

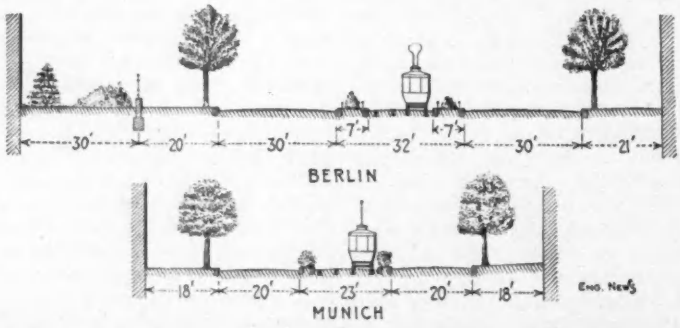


FIG. 11. SECTIONS OF STREETS IN WHICH THE TRACK RESERVATION IS BORDERED WITH SHRUBBERY INSTEAD OF TREES

to establish this arrangement, in order to separate street traffic from car traffic. In his opinion (agreeing with Mr. Wattman), the placing of this reservation in the middle of the street (as in Fig. 11) is decidedly preferable to placing the tracks on both sides of the street (as in Fig. 7). He gives reasons as follows: (A) wagons can stand and deliver goods at the curb line, (B) there is greater safety for children playing in the street and for persons crossing it, (C) the paving of the roadway can be selected and designed for the best service with vehicle traffic without interruption by tracks, (D) the clearing of the sidewalks can be effected without interfering with the tracks, (E) in case of repairs, the traffic can be diverted temporarily from one track and the work can be done without interference with the roadway, (F) persons waiting for cars can stand at the side of the reservation and out of the way of roadway traffic; (G) there is less danger and delay to persons getting on and off the cars, and (H) the delays caused by vehicles which persist in driving on the tracks are avoided entirely. Objections made are: (A) the inconvenience of passengers having to cross the roadway, and (B) the inconvenience due to dividing the roadway into two parts. These are not considered of great importance, however, and the latter may be reduced by providing a sufficient number of passing places.

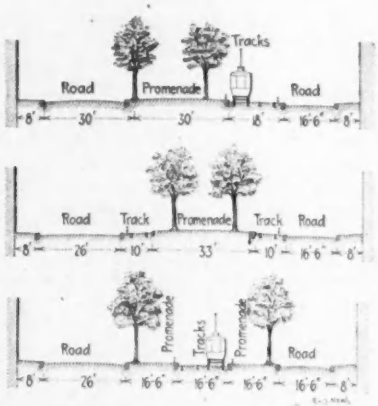


FIG. 12. SECTIONS OF STREET WITH SINGLE PROMENADE AND SPECIAL RESERVATION FOR CAR TRACKS

The arrangement of a special reservation for the tracks is specially advantageous for suburban traffic to insure rapid communication between the suburbs and the city, which is essential for good service and for the development of the suburban districts.

Formerly, the surface of this track strip or reservation was paved or (in the outskirts) covered with broken stone. However, this latter causes much dust, and paving is nearly always required. The paving blocks may be smaller than those used for the street since they have not to carry traffic, and the cost is thus relatively small. But cost is not the only consideration; the small blocks are liable to be displaced by heaving after frost, causing danger of derailment at high speeds or the destruction of snow plows and safety guards or fenders. A bituminous macadam covering seems well adapted to meet the conditions. Where possible a platform should be made outside the tracks, this being covered with grass and flower beds (and paved at the stopping places).

Experiments have been made in Berlin with turf laid over the entire strip, and the results have been very satisfactory. The surface of the turf should be 2 to 2½ in. below the rail head, and the grass kept close cut so that it will not lie on the rail and interfere with the action of the brakes. This turf strip, ornamented with flower beds, gives a very pleasing appearance to the streets and has resulted in an increase of the value of frontage property. There is no dust, no vibration is felt in the houses, and the cars ride noiselessly. Further, this treatment is much less expensive than paving, even when the cutting and watering of the grass is taken into account. It is advisable to keep the axleboxes of the cars in good condition, so as to avoid the dripping of oil.

Where the width of the street does not permit of a special reservation, the arrangement shown in Fig. 14 has been employed with success in the suburbs of Berlin for some years. The track space is paved with stone, and the roadways with asphalt. This paving has required no repair for three or four years, and even the joint between the asphalt and stone remains in good condition, due to the fact that the bed of gravel and broken stone under the stone blocks give about the same elasticity as the asphalt covering. In some asphalted streets the tracks (paved with stone) are at each side of the street, as in the lower part of Fig. 6. Bituminous macadam instead of stone has been used at Montreux, to avoid the noise due to vehicles passing from the stone to the asphalt paving. This material also allows of driving horses on the tracks (without undue noise) when the asphalt is rendered slippery by light rains or by watering. But drivers will not go on the tracks when the asphalt is dry and clean, so that there is little fear of undue obstruction to the cars.

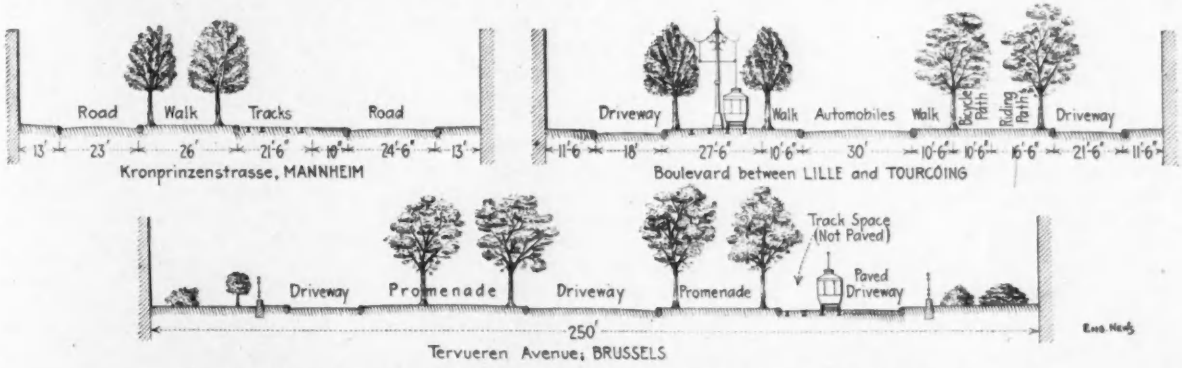


FIG. 13. SECTION OF BOULEVARDS AND MAIN ROADS ON WHICH CAR TRACKS ARE LAID

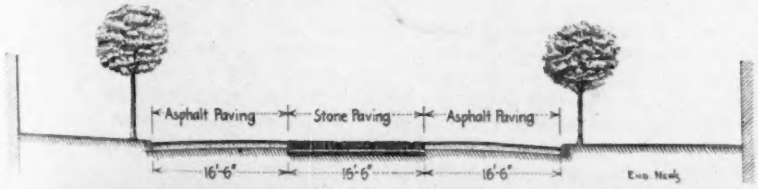


FIG. 14. SECTION OF NARROW BOULEVARD IN BERLIN, HAVING CAR TRACKS

The Effective Value of a Street Railway rail increases with the frequency of the service, according to W. Thom, in a paper before the Tramways and Light Railways Association, of England. The explanation is that the more cars over a rail, the fewer trucks and wagons, which wear the rail more than the cars,

A New Impact Formula

From the Rules of Design and Dimensioning Bridges on the New York Connecting R.R.

By Gustav Lindenthal*

On the New York Connecting R.R. there occur, in a length of a few miles, viaducts and bridges of several types, with short and long spans, made of low and high steel, for single-track and multiple-track roadway, having ballasted and open floors, through and deck trusses, arches of reinforced concrete, etc. In the dimensioning of these various structures it appeared desirable (among other things) to have a uniform method of providing for the dynamic effect of railroad trains at fast speeds, usually called the impact effect.

Nature of Impact

The causes which produce dynamic stresses on railroad bridges, although long known, are too complex, too numerous and too variable for accurate determination.

Anyone that ever rode on a locomotive is aware that the concussions and vibrations of the machine at high speeds are exceedingly violent. Driving-wheels can be balanced but for one speed, usually a medium speed. The wheel pressures from a locomotive standing still bear no resemblance to the wheel pressures at high speed; these latter may vary from minus 50% at one end of the axle to plus 200% simultaneously at the other end of the same axle, by reason of the cranks and balancing weights being at right angles.

The tremors of the locomotive are transmitted to the track, which receives vertical blows as well as lateral ones. Poor rail joints further increase the swaying motion of the ponderous machine, which at the high speed of our limited expresses is thus leaping rather than smoothly rolling. The tender immediately connected with the locomotive receives from it a share of the concussions and of the lateral motion, called nosing. On long bridges the effect of the shocks from locomotive and tender is supplemented by the shocks of the cars from flat wheels, axles out of square, etc.

The strains from all these causes defy analysis, but withal must be taken into account. In a general way we know that on short spans and light bridges the dynamic effects are large, and that in long spans or on heavy bridges they are much smaller.

Misfit Impact Formulas

All the rules in use for impact are empirical. Some of them give, for the usual structural steel, the usual open floor, and for ordinary spans (up to 200 ft.), values fairly in agreement with observed effects; but they do not fit other conditions. Some other rules, which pretend to a scientific basis, have even less merit. Such, for instance, is the rule of doubling the live-load stress (i.e., adding 100% in all cases), on the theory that a load suddenly applied will cause momentarily double the static stress of the same load gradually applied (within the elastic limit). This law is true only if the load is not cumulative and when the sudden loading is applied without shock or concussion—an essential condition which, however, does not likely occur outside of a laboratory. All railroad loads are accompanied by more or less shock, concussions and vibrations even at slow speeds. Static stress, even if doubled through suddenness, may be relatively small and accompanying shock may be large, or the reverse. In any event, if the sudden (known) stress plus (unknown) shock, strain the metal below its elastic limit, it will be safe; if beyond the elastic limit, no matter how short an interval, then the metal will break from frequent repetitions in course of time. There is, outside of these facts, no mysterious destructive force in that vibration, caused by shocks. Their intensity is unknown, it is not computable; it can only be judged from its effect upon the strength of the metal.

But it is highly probable that the intensity of these shocks increases nearly as the square of the speed of the trains, and often is in some members much larger and in other members much less than 100%.

To harmonize the misapplied theory of sudden load with observed facts, it was found necessary to use different unit-stresses for different members in the same bridge—one for the stringers, another for the floorbeams, another for web members, another for chords, etc. Sometimes 6 to 10 different axial unit-stresses (for tension, reduced for compression) are thus used in the same design. This variety requires a corresponding variety in the unit-stresses for shear, bearing, bending, etc., resulting in very cumbersome, confusing and rather imaginary strain sheets.

Other impact formulas use a single basic unit-stress and assume a live-load addition varying in some inverse ratio with loaded length of span, from an upper limiting value of 80 to 125% addition.

Attempts have also been made to deduce formulas from extensometer measurement of strains in existing bridges, but with puzzling results. Primary and secondary strains from live-loads are often of opposite sign and cannot very well be separated in such measurements; besides it is a mooted question whether the momentary strains from shock can be measured at all with any instrument so far invented.

For one reason or other the various formulas in use appeared unsuitable for the variety of structures to be designed. A new formula was therefore evolved by the writer, which gives for all cases values as close to truth, it is believed, as can be obtained with elements so undefinable.

Derivation of New Impact Formula

The reasoning starts from the well known fact that good iron and steel (when the dead-load stresses in them are so small as to be negligible) will safely and permanently endure the stresses from external forces accompanied by the usual shocks, concussions and vibrations of moving masses, when dimensioned with a factor of safety of 9 to 10 for the statical stress. If designed with a much smaller margin of safety such parts would break sooner or later. Experience has determined that fact with shafts, car and locomotive axles, connecting rods, gear wheels, machinery parts of all kinds, rails, etc.

We have also the other fact that for quiescent stresses, as from dead-load, a unit-stress equal to one-third of the ultimate strength (factor of safety of 3) or two-thirds of the elastic limit of the steel, is absolutely safe.

(The terms "stress," i.e., the force exerted in a body, and "strain," i.e., the change of form under stress, are in this article used interchangeably. The distinctions made by physicists may not always be observed by engineers.)

For members subjected to stresses from both dead-load and live-load, the safe unit-stress will therefore be somewhere between one-third and one-ninth of the ultimate strength. As it is desired to use hereafter one-third of the ultimate as the basic stress throughout, the addition for the dynamic increment (I in the formula for total stress, $S = D + L + I$) will vary between 200% for members having only live-load stress, to zero for members having no live-load stress.

For any case in which dead- and live-load stresses occur together, the increment will depend upon and be modified by two principal conditions.

First condition:

The intensity of the impact is a factor. It depends upon the relative masses (or weights) of the locomotives (including tenders) and the cars, respectively.

The real troublemakers for tracks and bridges are (as stated before) the locomotives; the top-heavy swaying tenders are only little less injurious. For the locomotives and tenders an addition of average 200% to the static stress will bring the strains from them within the indicated factor of safety of 9. This is the same thing as taking three times the quiescent statical load.

The shock from the cars is less. They roll comparatively smoothly behind the

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locomotives, except for occasional flat wheels and poor rail-joints. To account for the latter an addition of 100% is ample. But with rails 33 ft. long, and with the heaviest cars having four axles in about the same length, only every fourth axle may be assumed as delivering simultaneously that 100% impact at the rail-joints. Therefore, 25% of the car-loading per lineal foot may be taken as an ample provision for impact from cars.

If Q is the weight of locomotives and tenders, q the weight of the car-loading per lineal unit of track, and a the length of train behind the tender, then the intensity of impact may be expressed as a stress P.

$$P = L\frac{200\%\,Q + 25\%\,qa}{Q + qa} = L\frac{8Q + qa}{4Q + 4qa} \qquad (1)$$

Second condition:

The effect of the impact, as distinguished from its intensity, is also a factor. The intensity may be said to exist at the beginning of the shock, the effect at the end of it.

Opposed to the shock (accompanying the statical stress from live-load) is the elastic resistance of the entire cross-section of the member, which is always proportioned at least for both dead and live-load ($D + L$). The elastic resistance has a retarding or braking effect upon shock. Its momentum is converted into the work of momentary elastic changes in the form or length of the members, manifesting itself by vibration. Although the forces act in an immeasurably short time and through an insensibly short distance, and cannot be accurately known, it is obvious that the elastic resistance to shock increases with the mass or in this case with the cross-section impinged upon, and that it decreases the intensity of the shock provided the strains are within the elastic limit of the material. It is impossible to equate dynamic work, were it known as to amount, with statical forces (as the energy of shock opposed by elastic retardation) in terms of stress, which alone could be used for dimensioning. But approximately we can say that the reduction of the impact will be proportional to the cross-section of the member and can be expressed by the relation

$$\frac{L}{D + L} \qquad (2)$$

in which L represents the live-load stress plus any effect of sudden loading and shock, and $D + L$ represents the cross-section of the member. This term is already in use in impact formulas.

Concurrent Live-load Effects

It should be kept in view that strain from moving load or live-load does not resemble the quiescent strain from dead-load. Live-load strain is restless, oscillating up and down from its static value. During each oscillation it is subject to acceleration by gravity, reaches a maximum, and is then decreasing through retardation from the elastic resistance of the material; and so on until the oscillations die out.

The effect of shock is different. When its intensity is largest (in the beginning), the strain from it is zero; but as soon as its intensity produces strain, it instantly decreases in intensity.

These two strain effects, one alternately growing and decreasing through acceleration and retardation, the other instantaneous but reduced by retardation—are concurrent and inseparably commingled, which makes it further impossible to ever determine with any accuracy their relative strain values.

The value P of equation (1) can from experience be safely assumed to cover within the limits of $P = 2L$ both effects, just as the retarding force acting upon P can be assumed to be approximately proportional to

$$\frac{L}{D + L}$$

The cushioning effect of stone ballast or other heavy floor, for instance, is apparent, in that dead-load stress D will then be larger, and thus the retarding force greater.

Combining the two relations (1) and (2) we obtain the true increment

$$I = \frac{L}{L + D} \times P = \frac{L}{L + D} \times L\frac{8Q + qa}{4Q + 4qa}$$

$$= \frac{L^2}{L + D} \times \frac{8Q + qa}{4Q + 4qa} \qquad (3)$$

which is a general form for railroad bridges, capable of use with either English or metric measures.

Substituting for Q the weight of two locomotives and tenders (of Cooper's E60 loading) $= 2 \times 426{,}000 = 952{,}000$, and for q its corresponding value of 6000 lb., we obtain

$$I = \frac{8 \times 952{,}000 + a\,6000}{4 \times 952{,}000 + a \times 4 \times 6000} \frac{L^2}{L + D}$$

or approximately,

$$I = \frac{L^2}{D + L} \times \frac{1200 + a}{600 + 4a} \qquad (4)$$

which is the form used for the bridges of the New York Connecting R.R.

Reliability of New Impact Formula

It will be interesting to examine further into the adequateness of the premises from which the foregoing formula was deduced. Objection might be made to it on the ground that a more accurate expression for the increment from impact would be found by using a live-load diagram similar to the one for the quiescent live-load, but with double the axle loads for locomotives and tenders (for the 200% addition) and with only one-fourth the car-loading behind them (for the 25% addition); and then computing from such loads for each member the impact stress K, with the aid of influence lines similarly as for the quiescent live-load. The stress K would then take the place of the term P for intensity, Eq. (1) above given.

The supposed accuracy in determining the true increment I would then further require that the full cross-section ($D + L + I$) be taken instead of merely ($D + L$) as in the expression Eq. (2) above given.

The retardation will then be proportionate to $\frac{K}{D + L + I}$. Let the maximum force to be retarded now be assumed as ($L + K$), in which L is the addition for sudden loading and K the intensity of shock.

Then the increment will be

$$I = \frac{(L + K)\,K}{D + L + I}$$

Solving for I leads to the quadratic equation from which is found

$$I = \sqrt{K^2 + KL + \left(\frac{D + L}{2}\right)^2} - \frac{D + L}{2} \qquad (5)$$

This method of first finding the impact stress K and from it the increment I is too cumbersome and not worth while, as the arithmetical values of the formulas (3) and (5) do not differ greatly if at all.

The values obtained from the simpler formulas (3) and (4) give the increment for impact in percentages of the static live-load stress L, which is more convenient and the values are sufficiently close for all practical purposes.

The deduction of formula (5) shows, however, more clearly than that of formula (3), that the value I in either formula includes the effect of sudden loading, as well as that of shock.

It also agrees with known and observed facts as far as these can be judged.

Impact in Special Cases—For trusses carrying multiple tracks, the increment I is reduced

10% for two tracks
20% for three tracks
30% for four tracks

The reason for this is obvious. The maximum stresses from live-load in trusses carrying multiple tracks are multiples of the maximum on single track, which means that the maximum live-loads (the heaviest freight trains) on all tracks would all have to run at high speed in the same direction and with locomotives abreast. This is a highly improbable, although not impossible loading. But should it happen, the bridge would still be absolutely safe with that reduction in the impact effect on trusses above prescribed.

When D and a are zero, as for instance for a rail supported on ties, the stress $S = D + L + I$ becomes $S = 3L$. That is, the effect of live-load and impact is then equivalent to three times the effect of quiescent load, which is, as stated be-

fore, the basis from which the reasoning started.

No one knows, and probably no one can know, whether the live-load stress plus shock actually occurring under the conditions named is 3 times (or any other multiple of) the static quiescent stress. We do not need to care much whether it is or not. The important, guiding and fundamental fact, established by experience, as shown, is that the physical effect upon the materials (as regards durability and safety) from live-load accompanied as ordinarily on railroads by shock, can reliably be expressed (and for the case in hand deduced) in terms of the static stress as indicated.

ADAPTABILITY OF NEW IMPACT FORMULA

In the impact formula

$$\frac{L^2}{D+L} \times \frac{8Q+aq}{4Q+4aq}$$

the values Q and q can be modified, if necessary, to suit the conditions of a special case. Safe and close-enough values can always be obtained, using round figures, with good judgment unobscured by mock-accuracy.

The weight of locomotives (and their number) may be varied as needed.

For smooth-rolling electrical cars, in which the rotating parts require no counterweight, the value Q disappears altogether and the impact becomes small, as it should.

For 60-ft. rails the value q can be taken smaller than 25%.

For ballasted floor the impact will be less than for open floor, etc.

The formula can be readily adjusted, as needed, to road bridges with their usual concentrated loads. It is also adaptable to bridges of concrete and wood.

SIMPLE RULES OF DIMENSIONING

In the "Rules of Design" for the New York Connecting R.R. the cross-section of a member carrying dead- and live-load is determined from the formula

$$A = \frac{D + L + I + Lat + Exc}{u}$$

u = Unit-stress, for tension or compression;

Exc = $(W + Br + Temp) - 20\%\ (D + L + I + Lat)$, and is used only when its value is positive;

Lat = Lateral stress from live-load;

W = Stress from wind pressure;

Br = Stress from braking;

$Temp$ = Stress from temperature changes;

all of which are defined in the rules.

For bracing carrying no dead-load or live-load stresses the section is determined by the formula

$$A_2 = \frac{W + Br + Temp + Lat}{u}$$

UNIT-STRESSES—For steel u = ⅔ of the elastic limit or ⅓ of the ultimate as determined by the engineer.

For ordinary structural steel

$$u = 20{,}000$$

For nickel-steel it would be

$$\frac{2 \times 45{,}000}{3} = 30{,}000$$

For wire cables it would be

$$\frac{165{,}000}{3} = 55{,}000$$

(165,000 being the ultimate strength of a wire strand with 200,000-lb. wire).

Unit-stresses for compression are for *net* sections, taken from a table.*

The dimensioning of bridge members in any span, whether 1 ft. or 2000 ft. long, and of any material and for any kind of live-load, is thus brought within a few simple, rational rules, without empirical guesswork. Different bridge types for the same span and loads, as for instance the arch, cantilever or suspension type for a 2000-ft. span, can be dimensioned by the same rules and thus their comparative weights and economy more closely determined than has up to now been done.

The rules for proportioning plate-girders are likewise simple, resulting in economical and well proportioned details.

In this manner one set of values was sufficient for the dimensioning of all the variety of bridge structures on this road.

*Tests with compression members of solid and perforated sections are in preparation to verify the values of net sections. These tests will be made by the U. S. Bureau of Standards and are expected to give valuable information, at present not existing, on that feature of compression members.

A Loading Formula for Hooped Reinforced-Concrete Columns

BY F. H. CONSTANT†

There is considerable difference in the building ordinances of the various cities in the authorized working stresses for reinforced-concrete columns, especially those with spirals or hoops. Some specifications adopt Considère's formula, in which the lateral steel is weighted 2.1 or 2.4 times the longitudinal steel, and some make no direct allowance for the hooping whatsoever. It seems to the writer that our experimental knowledge of the strength and behavior of the kind of reinforced columns usually included by these ordinances is now sufficiently definite to permit a closer unanimity in the framing of specifications. Differences of opinion in regard to the proper factors of safety will always exist. Whether such factors should be larger or smaller is a matter of judgment. But the base upon which the factors of safety should be reckoned is definite and determinable.

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All working stresses involve, whether expressly or not, the idea of a factor (call it safety or ignorance, as one will). The load on the column is not to approach a certain danger point by a certain safe margin or proportion. The first step is to establish the danger point, the next is to determine, by ripe judgment and experience, how near this point may be safely approached. In the earlier days of steel designing, this factor was based upon the supposed ultimate strength of the member. It is now known, however, that the ultimate strength, particularly in the case of columns, is a very indefinite and variable quantity, dependent upon the distribution of the material, the manner in which the parts are tied together, and the quality of the shop workmanship. No one would pretend to predict what the ultimate strength of a short steel column is. It may be anywhere between the elastic limit (in some cases of very poorly designed columns even less) and a greater amount. This uncertainty in the upper limit of column strength has led to its abandonment, in steel design, for the factor base and to the use of the elastic limit instead. Even the latter taken in regard to the column as a whole is not as great as was formerly supposed. In many cases failure occurs at the elastic limit, but in every case it is recognized that a column has failed, as regards its practical usefulness, when the yield point has been passed.

Consider now a reinforced-concrete column with longitudinal rods and effective hooping. All tests now show that such a column has a fairly definite yield point, but a most uncertain ultimate strength. The yield point is a fairly predictable limit, for at that moment the concrete nearly reaches the ultimate strength of a plain concrete column, and the longitudinal steel reaches its yield point. At this time the spiral hooping is stressed hardly at all. If the ultimate strength of a plain concrete column is 2000 lb. per sq.in., and the yield point of the steel rods is 38,000 lb. per sq.in., the yield-point strength of the column is given by the following formula:

$$P = 2000\ A_c + 38{,}000\ A_s \qquad (1)$$

where A_c and A_s are the areas of concrete and longitudinal steel respectively.

Beyond the yield point, the column begins to deform rapidly and appreciably and the hooping begins to be stressed. The reserve strength, however, beyond the yield point is very uncertain and may fall anywhere between 10 or 20% to 90 or 100% in excess of the yield-point strength. A fair average would be 40 to 50% increase of strength. With such an uncertain upper limit, it is clear that it should not be made the base for a factor of safety. Moreover, the column is subjected to excessive deformation and permanent injury beyond the yield point. Considère's formula, on the other hand,

is clearly based upon the ultimate strength of the columns and consequently should have no place in a working specification, for it is positively known that there is practically no stress in the hooping at the yield point. Instead of trying to establish an ultimate strength by formula, which is impossible, it is better to work for the yield point, which is subject to closer prediction (see Eq. 1) and then frankly admit that the ultimate strength lies a little beyond by a variable but unknown amount, depending upon many uncertain elements.

The second step in fixing upon safe factors of safety, is largely a matter of judgment. The fact that an excess strength beyond the yield point does exist in more or less uncertain amount, warrants the use of smaller factors of safety based upon the yield point than if the latter were also the ultimate strength, as it is in the case of plain and longitudinally reinforced columns without hooping. Referring to Eq. 1, the strength of a plain concrete column is dependent upon the richness of the mix and should be made to vary accordingly in a formula. Well made concrete of a mix not leaner than 1:2:4, at the age of three months, may safely be assumed to have a strength of 2000 lb. per sq.in. A factor of 2½ will give a working stress of 800 lb. per sq.in. If the yield point of the steel is 38,000 lb. per sq.in., the ratio n at the yield point is 38,000 ÷ 2000, or 19. The same ratio for the working stresses would give 15,200 for the steel.

There are several reasons, however, why a smaller steel unit should be adopted. In the first place, most of the reserve strength of the column is in the concrete, reinforced by the hooping, and not in the longitudinal rods which will begin to bend and deform and will get little or no additional load. In the second place whether, even inside of the yield point of the column, the full elastic strength of the rods will be developed or not, will depend upon the details and care of construction and especially upon the closeness of the spiral hooping, which alone makes it possible to develop fully the longitudinal steel stresses. It is advisable, therefore, that a little larger factor of safety be used for the steel than for the concrete. In the third place, because steel is more truly elastic than concrete, even for low stresses, it is certainly known that when $f_c = 800$, n is much less than 19, in fact somewhere between 10 and 15. While it is not fair to press this fact, since we are establishing the working formula by the factor-of-safety method based upon the yield point of the column and not upon the conditions actually existing at the time the working stresses are developed, it will, nevertheless, influence the conservative designer to use a somewhat smaller value of n than that at the yield point. Increasing the factor for steel to 3 gives 12,667 lb. per sq.in., or, say, 12,500 for working conditions, corresponding to a ratio of $n = 12{,}500 \div 800 = 15.6$. This is perfectly safe and conservative, provided the hooping is effective.

The working formula with these factors, and concrete and steel of the strength named in Eq. 1, now reads:

$$P = 800\,A_c + 12{,}500\,A_s \qquad (2)$$

This formula applies to columns composed of the best grade of concrete of a mix not leaner than 1:2:4, reinforced with at least 1% and not more than 5% longitudinal steel and with spiral wrapping or hoops of at least 1% equivalent longitudinal area and with a pitch which may increase proportionally from not more than 1½ in. for columns of 12-in. core diameter or less, to 3 in. for columns of 36 in. core diameter.

Since the ratio n, at the working stress point is not 15.6, but 10 or 12, the concrete actually receives more and the steel less than the quantities in Eq. 2. Since the concrete outside of the hooping begins to peel off when the yield point of the column is reached, which is indicative of a certain degree of failure, a fair factor of safety should be used for this part. On the other hand, such peeling is not disastrous and the factor may be made as small as for the hooped core, viz. 2½, remembering that this time there is no reserve strength. When the yield point of the column is reached the shell will begin to peel. By making A_c to include only the net area of concrete inside of the spiral wrapping, the actual concrete stress, both inside and outside of core, will always be kept below the 800 lb. per sq.in. Moreover, if the outside concrete is damaged from any cause, the column is not endangered thereby. The amount and closeness of the hooping is necessary to develop the longitudinal steel and create the reserve strength in the column.

Columns without hooping will fail at about the yield point of the same column with hooping. The elastic properties of both columns are about the same, viz., the stress-deformation diagrams in both cases give slight and identical curves up to the ultimate strength (in the one case) or yield point (in the other case). In the former case the curve stops here, since the column suddenly fails. In the latter case the curve continues, becoming rapidly more and more horizontal until the ultimate strength is reached. Evidently the column without hooping will develop about the same stresses at its ultimate that the other column does at its yield point. With no reserve strength in this type of column beyond the yield point, it is necessary to use larger factors of safety. With the same quality of concrete and steel used above a working stress in the concrete of 600 lb. per sq.in., corresponding to a factor of 3⅓, may be adopted. Again, a higher factor should be used for the steel since now it lacks the restraining effect of lateral reinforcement. A factor of 4 should be the minimum. The corresponding unit is 9375 lb. per sq.in. Less, rather than a higher quantity should be taken, or, say, 9000 lb. per sq.in. even. The formula for reinforced-concrete columns with no hooping then becomes

$$P = 600\,A_c + 9000\,A_s \qquad (3)$$

where

P = Safe load on column;
A_c = Total net area of concrete;
A_s = Area of longitudinal steel.

As before the concrete should be rich and it is expected that the steel is distributed in the usual way by means of numerous rods of small diameter, giving from 1% to 5% of reinforcement. All of the concrete in the section may be counted unless it is advisable to exclude a certain shell for pure fire-proofing, which may be subject to injury without weakening the strength of the column.

Where the diameter of the column is small, as is usually the case in top-story columns, carrying only the weight of the roof, it might be well to reduce the permissible column load determined by the formula by some proportion. Such light columns are more certain to receive their full load than the larger ones lower down, which support several floors. Secondary stresses due to eccentric loading and other causes are apt to be proportionately larger in light columns than in heavy ones. The slenderness ratio is greater in such columns and the tendency to buckle is more pronounced. Finally this same slenderness makes pouring of concrete more difficult and the quality of the concrete and the efficiency of bond more uncertain. A 12-in. core diameter might be suggested as the minimum limit for the formula and that below 12 in. the load P be reduced by a differential coefficient less than unity, to be determined by judgment.

It is probable that in large columns such as those 36 in. in diameter, the strength of the concrete is greater than here assumed. We lack wholly experimental knowledge upon columns of this size and until such deficiency is supplied, it will not be wise to increase the unit stress.

Accidents from Street Cars and motor omnibuses in London, Eng., during the first six months of 1912 were reported recently in Parliament as follows:

From January to June, 1912, the number of motor omnibuses running in the Metropolitan police area was 2461 and of electric cars 2661. During the six months ending June 31, 1912, 81 fatal accidents and 1615 accidents involving personal injury were caused by these vehicles; 69 deaths were caused by omnibuses and 12 by tramcars. Personal injury was done in 793 cases by omnibuses and in 822 cases by tramcars.

Letters to the Editor

Why Not Call an Engineer an "Energier"?

Sir—The "famous definition" says an engineer is a man who can do for a dollar what any chump can do for two. I contend that an engineer is a person who can use a monkey wrench, that is to say, one who can keep an engine running.

Whatever spell the term "engineer" might have cast formerly, it is now too much of a misnomer when used according to the famous definition. In my opinion, "Graduate Engineer," mentioned hopefully by a correspondent in ENGINEERING NEWS of Jan. 25, 1912, will not make a suitable handle. We have all grades of graduates from the Greek scholar to the barber, and we may expect in these days of correspondence and other lesser schools that they will continue to increase in numbers as the standards recede. Abbreviating will be preferred to compounding. This would seem to be the order now in the built-up language of the painstaking Germans, and I don't believe our people at least will climb over so many syllables to reach us.

In a little sally to the shop of a great publisher which appeared in a recent number of his "periodical of protest," E. Hubbard alludes to us schemers as "manipulators of energy."

That is the idea. If we could switch to *energy* instead of *engine*, as the basis of our appellation, our contemned friends couldn't get at it with a monkey wrench, and perhaps we might succeed in differentiating ourselves in the popular mind. Incidentally we would abandon their device (which is perhaps properly theirs), and at the same time elevate our title to the plane on which it belongs.

I submit the word *energier* as a substitute for the ancient word. The transition from engineer to energier is as easy as could be devised. The word already has a prototype in financier (also a man of brains) and would not require much "accustoming." It is admitted that if a new designation were adopted, for a time we would be total strangers to the people who now for instance wonder what a surveyor has to do with an engine, and know only one kind of mechanical engineer.

It is also admitted that we couldn't hope to rise clear from all of our barnacles at one jump, or ever, especially if we attain the measure of success in the social scale that should be ours. What we need is the services of some such expert as Fra Advertiser Hubbard to proclaim us, and if we can relinquish the old fetish to the monkey-wrench man, we may have a chance to get right with the public. I haven't calculated the moment of inertia which would factor in the change.

Yours in the faith that we are going to get more recognition and compensation.

PAUL KEYSER.

Portland, Ore., July 13, 1912.

More Concerning Shopwork for Engineering Students

Sir—Having read with interest "Shopwork for Engineering Students," by Prof. Winslow Herschel, in your issue of July 18, I beg leave to differ from Prof. Herschel in some particulars. If by "technical training" is meant technical education, it is not "a nearly unanimous opinion that technical training should be made more practical." There is a real demand that the colleges and schools should furnish a more nearly complete and thorough fundamental education and that there be given to the students the power to appreciate the relations, as far as possible, between theory and practice. A live commercial enterprise is the best of laboratories, but as a part of a system of education, such training or experience must be treated as a means, not an end. The late Mr. Crane was by no means alone in his desire that so called technically trained men should be skilled tradesmen, for some of our schools seem to heartily agree with that idea by unduly emphasizing the "practical." And certainly Mr. Herschel cannot believe that with a major part of students, in college "the one idea is to get enough credits to graduate." The writer ventures to suggest that if such a condition is true in any institution, there may be need for housecleaning or for an inventory.

It is unfortunate that we have not outgrown the term "learned professions." Are there not many lawyers, physicians, ministers, and teachers who are not "learned," and many "self made" men who are truly "learned"? Col. Prout's conclusion as to engineers is correct; but it is equally true that men in general "reach the limit of their usefulness from defects of character rather than from want of technical attainments." It is first of all the business of education to correct defects and to lead the student into the best possible conception of life. In striving to accomplish this end for the technical student, a proper amount of shop practice, experience or study is of great value and usefulness, and to the writer's mind the Cincinnati plan of Dean Schneider comes most near to reaching the ideal.

CHAS. E. ROGERS,
Professor of Civil Engineering,
Trinity College.
Hartford, Conn., July 22, 1912.

Is the Reinforced-Concrete Column an Economic Failure?

Sir—In your issue of July 4, 1912, p. 31, Maj. John S. Sewell takes the position that the reinforced-concrete column is an economic failure.

From the experiments which the writer has made, he is inclined to differ very radically with Maj. Sewell, and if we are to argue the question from the standpoint of test data—which is the only argument which should govern in an argument of this character—will the Major kindly cite the tests on which he bases this most remarkable conclusion?

The writer has been engaged not only in reinforced concrete, but actively in structural steel for the last 20 years or more, and is at a loss to understand how to build a structural-steel column, the diagonal of which will not exceed 18 in., which will carry from 600 to 700 tons at a cost less than three times as great when fireproofed as a reinforced-concrete column. If the Major will kindly furnish his tests indicating what he can do in that line, the writer will be pleased to supply tests that have been made of reinforced-concrete columns of this capacity. This will bring the matter to a direct fair issue and will be better than discussing the subject from the standpoint of assumptions as to the modulus of elasticity of steel and concrete which seem so to befog the conception of the majority of writers and engineers that they forget that the real question is what the combination will carry under test and not what one or another genius may figure that it may carry based on certain assumptions.

C. A. P. TURNER.

Minneapolis, Minn.,
July 20, 1912.

Notes and Queries

W. C. & Co. write:

Will you kindly advise us as to any sewerage system where any form of siphon has been used to carry sewage over a hill, either successfully or unsuccessfully.

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Engineering News

The Reduction of Typhoid Fever at Minneapolis

There is still something to be learned concerning the relative parts played by public water supplies, on the one hand, and the combined effect of privies and flies on the other, in the prevalence of typhoid fever in some of our cities. A recent inspection of a spot map in the office of the health commissioner of Minneapolis showed a large number of privies in use in that city; and yet, since the water supply has been treated with hypochlorite of lime the previously high typhoid has fallen to a very low figure.

The record is a short one, however. Perhaps the 1911 figures will prove to be only temporarily low. Perhaps the relatively short heated season at Minneapolis is against many flies. Possibly the fly theory has been overworked. We are inclined to the latter view, especially as regards Northern cities. On the other hand, a careful study of typhoid and infantile diarrhœa incidence at Minneapolis for a long series of years might convict the privy and the fly of a large amount of manslaughter.

We raise these points merely as suggestions concerning the need for still more extensive study of the typhoid problem in different parts of the country. It is certainly true that public water supplies ought to be relieved of all blame not belonging to them, as a matter of justice and more particularly in the interest of the exact knowledge needed to reduce typhoid fever to the irreducible minimum.

Experience with Rail Sections

A partial solution of the rail problem has been reached, say the authorities of the Southern Pacific-Union Pacific system. They claim that the question of shape of rail-section, one of the large elements of the rail problem, is answered by the highly favorable results obtained on their lines with the "Type A" section recommended a few years ago by the American Railway Association.* The Type A section, proposed to the Association by the engineers of this very system, has been laid quite extensively on its main-track sections during the four years in weights of 90 to 96 lb., and the service results have been carefully watched and analyzed. The question of rail-section, of course, is chiefly concerned (in the statistical sense) with rail breakages, and the present announcement by the Southern Pacific therefore means that the Type A rail has practically eliminated fractures in service, except defective-metal fractures.

*Eng. News, May 14, 1908, p. 530.

The statistics on which the announced conclusion is based have not been made public. Such statistics are subject to differences of interpretation, and the conclusion will be accepted with some reservation until the figures have been laid before the world and reviewed by the advocates of other rail-sections. Moreover, it will not have full force unless supported by the results obtained on other railways, for the rail problem is full of byways and pitfalls. But when thus established, the conclusion will mark a decisive forward step in the railway field, and will carry the rail problem measurably nearer to its full solution. Indeed, considering the studies of rail quality, influence of manufacturing methods, etc., now being conducted by the American Railway Engineering Association, by steel-mill experts, and by railway officials, it is possible and even probable that by the time the conclusion as to form of section is convincingly established the entire rail problem will be fairly well solved—at least for present-day purposes.

The demonstration of the success of the Type A rail means incidentally that the old standard, the American Society of Civil Engineers section, has been actually convicted of the charge often raised and often denied, namely that the old section is not sufficiently robust for the stresses and impacts of service. Results showing that the new section reduced the number of unexplained fractures are proof that the old section brought about such fractures. But this fact need not concern us, as compared with the affirmative fact that the new section is satisfactory. For, the showing in favor of the heavier base of the new section will not be disturbed by any doubt as to the influence of hardness, since the tendency is toward harder rails, i.e., away from the field in which the thinner base might perhaps dispute the claim of superiority.

A satisfactory conclusion as to rail-section is independent of disputes over quality of metal. The Southern Pacific engineers, in speaking of the results as to the Type A section, say also that their latest specifications are believed to be wholly satisfactory, and that recent improvement of inspection methods will fully assure them of a product equal to the specifications. But these matters are bound to be more open to discussion than the matter of section, and conclusions concerning the one will be independent of the other. The single advance now heralded, a final conclusion as to shape of section, does not depend on opinions about mill practice or quality, provided the service statistics are not vitiated by variations of quality.

A Typical Criminal Negligence Case

An accident, according to the dictionary, is an undesigned or unforeseen occurrence of an afflictive nature. For a true accident, then, no one can be responsible; it is, in the language of contracts, an "act of God." Unfortunately most of the disasters that go to make up the accidents of an engineering nature, such disasters as are noted in the accident columns of this journal, are not accidents under this definition. While rarely they are "designed" to bring about the loss of life and property, only too often certain weaknesses in system or design could have been "foreseen" by the exercise of the proper amount of technical intelligence. The failure to exercise such intelligence by responsible persons is classed by the law under the general term "criminal negligence" and is punishable by fine or imprisonment.

After every structural accident which results in serious injury or loss of life, there is always a clamor for the punishment of those responsible for the disaster. In the natural course of events this clamor soon dies away, and the public desire for punishment is lost in the horror of another accident. Generally, however, the public officials whose duty it is to look into such affairs manage some sort of an investigation which often results in the stock charge of criminal negligence against someone more or less intimately concerned with the design or construction of the structure involved. By this time the public has forgotten entirely about the event, and the newspapers, alive to news values, devote only the briefest space to the announcement that the charge was not proved, and the accused is acquitted.

This is almost the invariable procedure; it is practically impossible to convict on a charge of criminal negligence, partly because of the difficulty in placing responsibility and partly because of the variance in hired experts' opinions as to correct practice, but mainly because the ordinary legal procedure pretty effectually clogs the wheels of justice instead of oiling them for more efficient service. Take, for example, the typical case of the Porter Ave. Pumping Station failure, noted on another page of this issue. Nowhere could be better shown the cumbrous nature of the punitive branches of our government.

Immediately after the accident an inquest was held before a judge of the City Court of Buffalo. As a result of this inquest the judge decided that the failure was caused by the omission of some bracing in the steelwork of the roof. He recommended the holding for punishment of the architect and the contractor for the steelwork. At a hearing on these recommendations before another court, the judge of that court decided that the steelwork had nothing to do with the failure, but that it was due to errors in the foundations. He therefore exonerated the contractor, but still held the architect. On the basis of these findings, the district attorney presented the case to the Grand Jury, which held to the view that the foundations were the responsible factors in the failure, but refused to indict anyone except the city commissioner and deputy commissioner of public works. Later this indictment was quashed by another judge who held that it was brought on insufficient evidence. Meanwhile, a commission of engineering experts appointed by the city council decided that the failure was due to errors in the steelwork, and that the foundations were not responsible. Finally, a jury has awarded a verdict of some thousands of dollars to the widow of one of the victims against the City of Buffalo, holding that the *city* was responsible for the failure.

Here is a most wonderful tangle of views, opinions, decisions and rulings, and in the end the taxpayers of the city will undoubtedly have to stand a heavy loss which obviously could have been saved by proper construction. Certainly someone is responsible, but in the maze which the legal luminaries and authorities have produced, there is no hope of reaching the right man. It would seem that there might be some method of conducting these examinations with a little more engineering talent and a little less legal assistance, though in these degenerate days we would not for a minute be classed with those who doubt the infallibility of our judges. But our faith in those who hold court in Buffalo is a trifle strained. If that be treason, make the most of it.

Reservoir Control of Mississippi Floods: A Rough Computation

Public agitation over this year's flood in the lower Mississippi has started up anew the discussion of schemes for controlling that great river. These schemes originate in most cases with people of excellent disposition, afflicted with that little knowledge which is proverbially dangerous.

We received recently a "publicity sheet," proposing a plan for "conserving" the Mississippi floods, which was said to be approved by a long list of organizations including various boards of trade, lumber-dealers associations, societies devoted to the uplift of drainage, irrigation, etc.

The general purport of this "plan" was that if the government would only take the surplus water which flooded the Lower Mississippi Valley this year's flood and use it to irrigate the arid plains of the West, there would result a hay crop of such astounding proportions that the cattle-raising industry would be revolutionized and the price of beef would shortly be cut in two. There were various other computations as to the benefits to be obtained from land drainage, water-power development, flood prevention, etc., and the overwhelming total was displayed in a manner that would make poor old Colonel Sellers ashamed of his feeble efforts as a promoter.

Perhaps these absurdities do not deceive engineers, but they do deceive a considerable proportion of the public and are seriously discussed in reputable newspapers. It seems worth while, therefore, to present a few very rough approximations to indicate in a general way what would be involved in the proposition to protect the Lower Mississippi delta from flood by storing the flood waters in reservoirs.

In the first place, how much reservoir capacity would have to be provided to really protect the Lower Mississippi Valley from floods so that it would be safe with the levee system at the present height. So far there has been no authoritative statement of the total flood flow of the Mississippi in the 1912 flood. Mr. Dabney, however, in his paper published in our issue of June 13, submitted data showing that the total volume of the flood was materially in excess of the great flood of 1897. The maximum flow in that flood was given by the late Major Starling in his papers published in ENGINEERING NEWS as 1,570,000 cu.ft. per sec. Suppose we assume the flood flow for this year at 1,800,000 cu.ft. per sec. and assume further that the flood volume necessary to be provided for in storage reservoirs would be equivalent to a flow of 800,000 cu.ft. per sec. continued for 20 days. In other words, the assumption is that the present river channel with its levees can take care safely of 1,000,000 cu.ft. per sec.

It is true that the maximum rate of flow did not continue for 20 days, but for a period of much more than 20 days the flood flow was far above the 1,000,000 cu.ft. per sec. rate, so the estimate above seems a fair one. Another way of checking its fairness is shown by the fact that the Mississippi's Arkansas tributaries alone are capable of furnishing a flood flow of something like 300,000 cu.ft. per sec. and that this much at least would have to be taken care of, in addition to a considerable percentage of the maximum flow from the Ohio, since that river alone can create a dangerous flood in the Mississippi.

Assuming, then, the necessary reservoir capacity as sufficient to store a flow of 800,000 cu.ft. per sec. continuing for 20 days, we have the total volume of water to be provided for equal to 1,372,400,000,000 cu.ft. Suppose that on all the headwaters of the Mississippi, Nature had kindly provided favorable sites for

storage reservoirs (as she has not) and that these reservoirs were constructed and the water stored therein to an average depth of 20 ft. A brief computation shows that the water in these reservoirs would cover and render useless 2160 sq.miles of land.

For an estimate of the cost of constructing these reservoirs, we cannot do better than to take the figure given in the recent report of the Pittsburgh Flood Commission, which has made very careful surveys and estimates of the cost of building 17 reservoirs to control the floods in the Allegheny and Monongahela Rivers. In round numbers the Pittsburgh estimate for constructing reservoirs to store 30,000 million cu.ft. of water is $30,000,000, or an approximate cost of $1 per 1000 cu.ft. of water stored. To store the Mississippi flood volume as above computed, therefore, would involve an investment cost of $1,372,000,000 in round numbers provided such favorable reservoir sites were available on the other Mississippi tributaries as exist on the tributaries of the Upper Ohio. It is well known that this is not the case and that in the comparatively level country from which much of the Mississippi River flows, it would be impossible to create storage reservoirs of any considerable depth and the land damages per million cu.ft. stored would be enormous.

It should not be understood that we present the above computation as an argument against reservoir construction for river control where the conditions are economically favorable and where the plan can be made practicable by proper engineering design. What we wish to protest against is the absurd propaganda in the newspapers and elsewhere which seek to commit the nation to all sorts of foolish and preposterous schemes, involving enormous expenditure, on the plea that this is progressive legislation and conservation of natural resources!

Block Signaling for Electric Railways

In the early days of interurban electric railways their operation was conducted largely on the lines of street-railway practice, but with the developments in speed, traffic and mileage the methods of operation have become closely comparable with those of steam-railway practice. The haphazard method of running fast cars under indefinite rules and with no other protection against collision than watching for opposing or preceding cars is nearly obsolete, and should be entirely so for lines of this class. It must be borne in mind that the traffic is often relatively heavy. Regular trains are run at intervals of 15 to 60 minutes in each direction, and extra trains (freight or passenger) are run as required, while near cities and towns local service may greatly increase the number of cars to be handled. The railways of this class are generally single-track lines. The very inadequate rules and lax discipline which are characteristic of the earlier lines, coupled with the unsystematic methods of operation, have been responsible for innumerable accidents. Sometimes these were due to plain recklessness, as where a man finding that an opposing car had not reached a meeting point, tried to run to the next siding without knowing anything as to the whereabouts of the other car. At other times they were due to the insufficiency of the operating rules or train orders. The dangers of such a system of operation increased rapidly with increase or number of trains, and especially with the increase in extra trains.

These conditions led progressive lines to adopt telephone train-dispatching systems, with telephones installed at the the passing sidings, so that the trainmen could call up the dispatcher for regular orders or for special instructions in case of emergency. Thus each train would have orders to proceed between definite points and to pass other trains at certain points, reporting their movements at such places. This was a great advance, not only as an operating system but also from the higher degree of discipline imposed on the men. It did not eliminate entirely the tendency to "steal a switch" when opportunity offered, and it had the objection that while the trainmen could call up the dispatcher at each siding, the latter had no way of notifying them in case he wished to issue new orders or change those already given. On steam railways, this object is attained by the use of the train-order signal, which is displayed by the station agent or operator when ordered by the dispatcher. This particular object has been attained to some extent in electric-railway service by the use of special train-order signals, which are installed at the passing sidings and are under the control of the dispatcher at headquarters. A motorman finding the signal displayed at any point knows that he is required to stop and communicate with the dispatcher.

All these methods tended toward safety and efficiency in operation, due both to the methods themselves and to their influence upon the men operating the trains. But there still remained the great objection that operation of train service was based on a time-interval instead of a space interval between trains. If a car broke down or was delayed, there was nothing to indicate to a following train that the time interval was not maintained. Further than this, it is often desirable to send several cars in one direction, and in going over the road it is difficult to properly space the cars and protect them from each other and from opposing cars. Under these conditions the block system has been taken up gradually, and special modifications have been devised to adapt it to this class of service.

The block systems used on electric railways are, in general, of two classes: 1, lights only; 2, semaphores and lights. A third class, which is used as yet only to a limited extent, is the cab-signal system, giving indications inside the motorman's cab instead of by outdoor signals; this may be supplemented by an automatic stop system for applying the brakes if a "stop" signal is disregarded. The train-staff system, also, is used but little by electric railways. In some cases the signals are operated by trolley contacts, especially in the class first mentioned; in other cases they are operated by track circuits. In all cases the signals are operated automatically by the cars, manually operated systems being ill-adapted for electric railways, where the operating staff is kept at a minimum. As most of the lines are single track, the trains must be protected from the front and the rear, and at the same time there must be facility for running two or more cars in one direction while holding an opposing car. All these requirements are complied with by signal systems now in use.

In steam-railway practice, block signaling is confined almost exclusively to the protection of traffic on continuous stretches of line, which are divided into consecutive blocks or block sections. In electric-railway practice, however, the block installations are of two distinct classes: 1, consecutive blocks (similar to the arrangement noted above); 2, isolated blocks. These latter are for the purpose of protecting traffic at such points as long curves (on unsignaled stretches of line), where the view ahead is very restricted. This requires but two signals, with a control point or contact at a point in advance of the signal. A car passing this point sets at "stop" the signal at the far end of the clock (against opposing trains), and on passing the signal at the rear end of the block it sets that at "stop" (against following trains).

In addition to the use of automatic block signals on the open road, it is becoming general practice to use interlocking switch and signal equipment at junctions and crossings. In such cases, of course, the signals form an isolated block for the protection of movements through the limits of the interlocking.

It may be judged from what has been said that the block system on electric railways is becoming as complete and effective as that on steam railways, and that its use is increasing steadily. While much credit for this is to be given to the managers and engineers of interurban lines, the conditions have necessitated spurring by legislatures and state commissions, whose action is started as a rule by occurrence of bad accidents on lines operated without proper protection. There has been the usual argument on the part of the railways that the cost was prohibi-

tive and the protection unnecessary. But with the continual succession of frequent accidents and occasional disasters, some states (either by direct enactment or through their railway commissions) have imposed specific requirements in this direction, and the indications are that the requirements will become more and more stringent, especially if the railways show opposition rather than coöperation.

In answer to, or objection to this, the claims are made that such systems involve unreasonable expense, and that they do not insure absolute safety, but are liable to be nullified by carelessness or recklessness on the part of individual men in charge of trains. The first objection can hardly be sustained. The second is true, of course, to the extent that such a thing as absolute safety is unattainable. But the degree of safety thus obtained as compared with that under ordinary train dispatching is so high that the objection is of slight moment. Furthermore, it is offset in two ways: 1, the very fact that a road is operated under the block system (even if only in part) exerts upon the men a strong influence conducive to care and obedience; 2, it devolves upon the company to employ men of good character and to enforce proper discipline, so as to minimize the dangers incident to carelessness or recklessness. It may be noted also, that the fact that outdoor signals are in plain view of passengers has a very positive influence upon the behavior of the motorman. The driver of a steam locomotive may pass danger signals without knowledge on the part of persons in the cars. But it would very soon be noted if the motorman of an electric car was to do this. In fact, some of the electric lines, in advertising their safety due to the use of block signals, suggest to passengers to "watch the signals" as a matter of interest.

There are as yet no standards for signaling on electric railways, but it is already being recognized that such standards are becoming necessary. One reason for this is the floating quality of the employees, the men changing from one road to another more frequently than those on steam railways, so that uniformity in rules and equipment of different lines is desirable for efficiency and safety of operation. This matter is being taken up by the electric-railway associations. The matter is somewhat more complicated than on steam roads, due to the use of two distinct types of signals, namely, semaphores and lights, as already noted. The semaphore type appears to be preferred generally, especially for interurban lines; the lamp signals are used more frequently on suburban lines, but they are used also on interurban lines.

One special feature of block signaling on electric railways which may be mentioned, is its occasional introduction to promote the safety of traffic and efficiency of operation at congested points on street railways. Such points may be of two classes: (1) junctions and crossings; (2) short stretches of track used by cars of various routes and forming specially congested "throats." To eliminate accidents and confusion, signals may be installed, and under such conditions they might in some cases be manually operated and in other cases of the automatic type.

The Municipal Zone System*

By B. Antrim Haldeman†

The origin and growth of the zone or district system of controlling city development in Europe, and more particularly in Germany, are briefly traced and its applicability in the United States is considered. Under this system the city authorities allocate different parts of the city to various classes of residential property, to manufacturing and to business purposes. This aids in preventing congestion of population and in planning street and street transportation systems, water-works and other facilities to meet the demands of various parts of the city. The author believes that the system might well be introduced in this country.

*Condensed from a paper, read before the City Planning Conference, Boston, Mass., May, 1912.

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Some of the nations of Europe, out of a wealth of unfortunate experiences in the rapid growth of industrial cities and the crowding together of the people in them, have evolved what is known as the "Zone System" for controlling the use and occupation of land.

The system had its origin in the deplorable living conditions which were forced upon the working people and poorer classes of Germany during the period of industrial progress that has absorbed the energy of the German people since the Franco-Prussian war, and during which old feudal towns have been transformed into metropolitan cities and the country-side into a forest of factory stacks. The administrative machinery of the towns, confronted with new and perplexing problems due to the rapid increase of population, were for many years unable to cope successfully with the new conditions by reason of the manner in which land was held, its sudden rise in value, and the lack of any authority to interfere in any effective manner with the owner's disposition and use of it.

The swift progress of industrialism throughout the German States encouraged the rapid growth of industrial towns at a time when the social conditions and the manner of living of the common people were not conducive to either the morals or health of crowded communities; the workshop and factory drew upon the farm and rural hamlet for their labor, and the working people, unable to obtain proper dwelling places, herded in caves, cellars, and unsanitary buildings, like rabbits in a warren. The rapid increase of urban population offered a fertile field for exploitation by the great landowners who erected barrack-dwellings of many stories and rooms which were an improvement over the caves and cellars and into which the working people crowded. Although these dwellings marked much improvement in living conditions they still bred many evils from the too intensive occupation and to correct these and provide greater assurance of the public health and safety a multiplicity of building regulations were enacted by the municipal authorities.

Ministerial Decrees were issued tending to enlarge the authority of local councils in matters relating to the erection and occupancy of dwellings; gradually the fact dawned upon the law makers that the power and prestige of the Empire among the nations of the earth depended as vitally upon the health and efficiency of its working people as upon the courage and loyalty of its fighting men. By slow degrees, slow because opposed by the great landowners who dominated many of the legislative bodies, the ministerial decrees were enacted into laws granting broad autonomy to municipalities and enabling them to strike at the root of the evil of their housing system by checking the increase of the speculative value of land, such speculative increase in some cities having risen 400% in a single year. Municipalities were also authorized to purchase ground, to erect dwellings, and to loan public funds to societies for the erection of workmen's homes; much encouragement has been given to the erection of one-family houses, and home owning has been made possible among the working people.

The story of the industrial and social

evolution of Germany is an intensely absorbing one, but we can consider here, and that but briefly, only the manner in which the municipal authorities exercise the powers vested in them to regulate the development of private property. This is accomplished mainly through the employment of the "zone system," under which the municipal department having charge of city planning, in establishing and extending the street system, also establishes the building lines, determines what percentage of the property may be built over and the arrangement of the buildings themselves, whether they shall be erected in solid rows, in pairs, or singly; also the distance between the buildings when built singly or in pairs, and the number of floors or stories. No appeal from the established regulations can be taken after the plans have been completed, examined, and finally approved by the several independent committees having jurisdiction. The plans frequently show three fixed lines in a block; the line to which the street is to be opened and improved, a line of restriction, a certain distance from the street line beyond which no building is allowed to extend, and an interior line fixing the boundary of the court yard or garden within which no structure is permitted.

The term "zone" as applied to the system is somewhat of a misnomer and misleading; although the general theory under which it is applied is, that the buildings should be lower and farther apart the greater their distance is from the center of the city, the arrangement is not one of concentric girdles, as might be supposed, but a division into districts, irregular as to area and boundary and regulated in accordance with some local characteristic or special adaptability for certain classes of buildings; in fact, it sometimes occurs that a "zone" consists of a single city block, or even part of a block. True zones girdling the city would result in alternating rings of high and low buildings or a single indeterminate outer zone, regardless of topography or local conditions, and are considered unwise, if not impractical; so also are very large zones, or districts, since the application of absolute restrictions would prevent the establishment of local business and trade centers for the convenience of the people.

The system has undergone considerable modification since its introduction; keen judgment and great care are essential in determining boundaries and in imposing regulations which will permit property to be used for the purpose for which it is best adapted; although there was, and still is, considerable opposition to it in some instances, it is gradually producing the desired results, checking land speculation and inflation of values, discouraging the erection of barrack-dwellings, encouraging the erection of one-family houses, and making it possible for people of modest means to own their own houses.

Just as the industrialism and commercialism of Europe has created congestion and bad housing conditions, so are the same evils following in the wake of the tremendous activity along industrial lines in this country; the centralization of trade and the lack of adequate transportation facilities are, perhaps, the most powerful factors in producing a too intensive occupation and use of land; the desire to make property produce the largest possible income is a characteristic of landlords the world over, and tenement houses under lax regulations are splendid revenue producers.

Although the zone system as employed in Europe is the outgrowth of a long and persistently fought battle for the improvement of housing conditions, it has resulted in other economical and administrative reforms and it is along these lines that its application in the United States might also produce important results and be of great benefit. It would enable the municipal authorities to predetermine the character of improvement in any given area and, as the permanence of the improvement would be assured, very large economies in planning of streets, the construction of public works, and the conducting of general public service could be affected.

Under the zone system the permanent population of any given area may be determined with a reasonable degree of accuracy before a single building is erected upon it; with this factor known it is possible to intelligently forecast the needs of the district for every class of public works and public service and to plan accordingly, with the confidence that whatever is done will be done properly, permanently and economically.

Transportation is the great, controlling factor in the growth and development of the modern city, and the most difficult problem municipalities are called upon to solve; its difficulties would be greatly lessened if the density of population could be kept within reasonably certain limits: this is understood in the German system of town-planning and the locations of the trams, or street-railway lines, are determined as the street system is extended and are based upon the volume of traffic likely to be created by the known population and the predetermined character of the territory they will serve; the same is true of main, or trunk, lines of every kind of underground service: sewers, water pipe, electrical lines, pneumatic tubes; and subways, pipes, and tubes for every purpose of subterranean transportation. The number and capacity of public-service structures under, upon, or above the surface depends upon the density of the population and the local needs of the community; these elements being known the original construction of public works can be of the most permanent character and the liability for repairs, reconstruction, and enlargement can be reduced to a minimum.

Wide streets, planned with the almost certain knowledge the zone system would give of the traffic requirements for long years of service, would permit of a far more economical system of secondary and residential streets than we now find in most of our cities. In almost every city we find large areas laid out with streets of uniform width and uniform improvement, but they seldom carry an equal amount of traffic or are of equal public use except in congested localities; certain ones, by reason of easier grades, better connections with important points, greater business activity, or other favorable local conditions, attract the greater volume of traffic, leaving perhaps half a dozen adjacent ones unused and unlovely expanses of costly pavement.

The zone system would permit property to be restricted to the use for which it is best adapted by natural conditions. If hilly and picturesque districts were reserved for high-class residences, or for residences requiring lawns or gardens, the cost of improvement, both as to property and streets, would be greatly reduced by removing the necessity for the usual formal street system and the great amount of grading required for the building of solid rows of houses on small lots.

It also frequently occurs that a quiet and attractive neighborhood that has been occupied for many years by the better class of residences, surrounded by well kept grounds, is invaded by rows of cheap houses, the character of the neighborhood enabling the builder to realize large profits; since these profits are generally the sole object of the builder the operation seldom fits harmoniously into the surroundings and almost invariably the result is that the character of the neighborhood changes and property loses some of its desirability and value, except for the erection of more rows of houses. Operation houses are usually built for sale rather than for stability and if their erection was confined to certain districts there would be a competition among builders that would result in a higher class of workmanship, more attractive arrangement and surroundings, and better value for the purchaser of a home.

The skyscraper, as an institution of the business life of America, is a costly luxury for which the public pays, and will continue to pay in ratio increasing with its growth, a heavy price in both cash and health; it increases enormously the difficult problem of transportation and with its brother evils, the subway and the tenement house, for both of which it is partly responsible, it is moving steadily toward the creation of an abnormal condition of urban life. This menace of the skyscraper, the subway, and the tene-

ment can only be removed by the enactment of regulations limiting the height of buildings, defining the areas within which those of maximum height may be erected, and prescribing the percentage of surface area they may cover and the amount of light and air space around them.

In no department of city building is there a larger opportunity for the advantageous application of the zone system than in the defining of the areas within which industrial establishments may be erected. Mills, factories, and workshops of almost any kind may now be set down in any locality which seems favorable to the promoter of the enterprise. Such establishments must invariably have facilities for transportation by rail or water, or both, especially if they are conducted upon a large scale, as most modern establishments are. Their random placing may work to the disadvantage of an entire neighborhood. There is a large economy for any concern in having transportation companies deliver and receive freights directly at its doors and the problem of supplying such service is a difficult and complicated one where industrial plants are distributed widely throughout a community.

The confinement of industrial establishments within certain prescribed areas would protect residential districts from invasion by incongruous or otherwise objectionable institutions and would immeasurably simplify the problem of industrial transportation, both local and foreign. The creation of factory zones in locations conveniently reached by rail or water would permit the development of terminals of maximum efficiency at minimum cost; drayage between the mill and the shipping station is a large item of expense to the manufacturer, and the collection, classification, and distribution of freights from or for scattered and isolated yards are distracting problems for the traffic manager and the yard master; the short haul, the reduction or concentration of trackage, and the saving of time and energy where freights originate, or are distributed, within certain prescribed areas, all count for economy in trade and transportation. Main traffic streets for through travel could be kept clear from obstruction by railroad crossings and sidings, and to a considerable extent from costly bridges, if freight yards and freight carrying lines were kept within the industrial zones.

So apparent do the advantages of the industrial zone seem, and so complex and costly are the problems of industrial transportation under present methods, that it is strange the manufacturers and transportation companies, in their efforts toward scientific and economic management, have not used their influence to establish such a system; indeed, some of the large industrial concerns have found such an arrangement so desirable that they have established their own industrial colonies in which their factories and freight service are entirely separated from the residential sections; only the most extensive ones, however, have been able to do this successfully, the smaller ones having found the problem of obtaining and keeping skilled labor a difficult one in colonies a considerable distance from large towns.

Any attempt to engraft the zone system into American schemes of municipal development would probably meet with great opposition from landowners, real estate speculators and operative builders, and from large interests not directly concerned in the development of land. The objections of the first would doubtless be based upon the abridgment of their right to do as they please with their own property, of the second upon the cutting off of prospective profits, and of the third upon the general proposition of the invasion of vested rights. All of these arguments were advanced against the system in Germany and all had to give way at the behest of the people.

The plea for the protection of the vested right has not the force it had a few years ago. The great unrest we find throughout the country today may readily be traced to the exploitation of nearly every line of activity under so called vested rights; the days of perpetual franchises and special privileges are passing away, and, while every reasonable safeguard must be maintained around the rights of property and invested capital, their leveling down to the service of people who have given property its value and capital its reward is proceeding steadily.

A long process of reasoning might be necessary to convince the people that our municipal officers may be trusted with such large powers as are involved in the practical application of the zoning system, for there is a too well-founded suspicion that public service does not always mean serving the public. But the administrative machinery of our cities is passing from the control of political and corporate interests to the control of enlightened public sentiment; the people have been thinking, and inquiring into public affairs, and they are learning that the city, with all its vast resources and wealth, is theirs, created by their energy and labor; they are learning what a tremendous organism the modern city is, and, in the pride of their own work, are beginning to assert their right to rule it. Municipal government in the United States is undergoing an evolution that points toward material improvement and the time may not be far distant when our cities will be governed as wisely and honestly as those of Germany, where the power of the local officials is so great, and so unrestrained by constitutional or statute laws, that only capable and trust worthy men dare be placed in the public service, and where election to a public office is a real honor.

The Collapse of the Porter Avenue Pumping Station at Buffalo; A Resume*

On the morning of Friday, June 30, 1911, the central portion of the concrete-tile roof of the Porter Ave. pumping station of the new Buffalo water-works fell in without warning, killing in its collapse eight workmen who were at the time engaged in laying the tiles on the cinder-concrete slabs which formed their support. During the year which has since elapsed, the accident has been the subject of many judicial and official investigations, the substance of which have from time to time been reported in these columns. In order to bring together all of the history of the case, we present here a resumé of the various stages in the progress of the investigations, compiled for the most part by a Buffalo engineer who has kept in touch with the whole proceedings.

The accompanying figure shows the general outlines of the building, and the extent of the collapsed area. The slabs which rested upon the roof purlins had been poured some weeks previous, and almost exactly one-half of the roof tile had been laid when the accident occurred.

Two reasons were assigned for the failure; one, insufficient bracing of the trusses, and the other an inner movement of the walls supporting the roof bearing columns. The latter reason assumed a force acting on the lower chords in such a manner as to impair their tension and to place them in compression, thus destroying their usefulness and buckling the upper chords to their consequent failure.

The district attorney immediately brought "John Doe" proceedings before Judge A. A. Hartzell of the Buffalo City Court, who finally decided that the collapse was due "to the omission in the roof of purlins at the peaks of the trusses . . . or the omission of sway or X bracing in the roof of the building" and "that the concrete wall or substructure in no manner caused or contributed to the collapse of the building." Judge Hartzell ruled that the omission of the proper bracing was due to the culpable negligence of the architect and superintendent of construction (one and the same person) and to the subcontractor for the steelwork, and that this negligence constituted the crime of manslaughter in the second degree.

A preliminary hearing of the case of the steel contractor on this charge was soon held before the City Court, Judge Wm. P. Brennan presiding. This hearing lasted about five weeks, and at its end Judge Brennan exonerated the accused, and ruled that it was not proved

*See Engineering News, July 6, 1911, p. 30; July 13, 1911, p. 56, for earlier accounts of collapse.

that lack of bracing was the cause of the collapse. He further stated that "a preponderance of the evidence favors the theory that the cause of this catastrophe was the deflection of the east foundation wall." Judge Brennan, however, considered the architect responsible as charged, and held him for the Grand Jury.

The District Attorney presented all of the evidence in his hands to the Grand Jury, which decided that the collapse was not due to the absence of bracing, but was caused by defective foundations. No bill was returned by the jury against the architects, engineers or contractors concerned, but indictments were brought against the Commissioner and Deputy Commissioner of Public Works of the City of Buffalo.

The indictments against these two officials were dismissed by Justice C. A. Pooley on Mar. 29, 1912, on the ground that the evidence before the Grand Jury did not warrant the indictments.

The latest legal step in the case was a verdict of $14,000 rendered on June 29, 1912, against the City of Buffalo in favor of the widow of one of the workmen killed. From this verdict both plaintiff and defendant have appealed.

Previous to the beginning of the damage suit, the Mayor was authorized to appoint a Commission composed of August C. Esenwein, a Buffalo architect; William G. Houck, President, Buffalo Structural Steel Co., and Robert G. Reidpath, a Buffalo structural engineer, "to examine the buildings as they now exist, to study the plans, and to make a report to the Mayor as to what portion of the buildings, if any, which are now standing will have to be taken down and removed, and what portion can be utilized in completing the pumping station, and to make such further report . . . as they deem advisable." This report was rendered July 15, 1912, and is abstracted below.

The accompanying figure shows an outline plan and longitudinal and cross-section of the pump-house building, which is 364 ft. long and 100 ft. wide. The foundation concrete walls rest on solid rock and are 5 ft. thick at the bottom, 3 ft. at the top, with an average height of 40 ft. The steel columns supporting the Fink truss roof are 55 ft. high, composed of two I-beams, an 8-in. beam on the outside and a 10-in. one on the inside. There are 23 columns on each side, spaced as shown. Other details of the structure are self-explanatory.

The Commission mentioned above reported upon all the buildings comprising the pumping plant, which includes boiler house, coal room, locker and oiler room, machine shop, office building, roof and traveling-crane support over canal and pump room. As only the criticisms and recommendations concerning the pump house are relevant, only these are given as follows:

Before the construction of the superstructure was begun, it was discovered that the east wall had deflected into the building. This was probably due to the jar caused by the blasting in the vicinity, passing trains, and the pressure of the earth filled in against it on the exterior. Subsequently reinforcing buttresses of concrete were built on the inside at points opposite the location of the columns to prevent further deflection. It is our opinion that the deflection did not increase after the work of constructing the superstructure was started.

Upon examining the plans and comparing them with the work in the building, we find considerable deviation in the steel work.

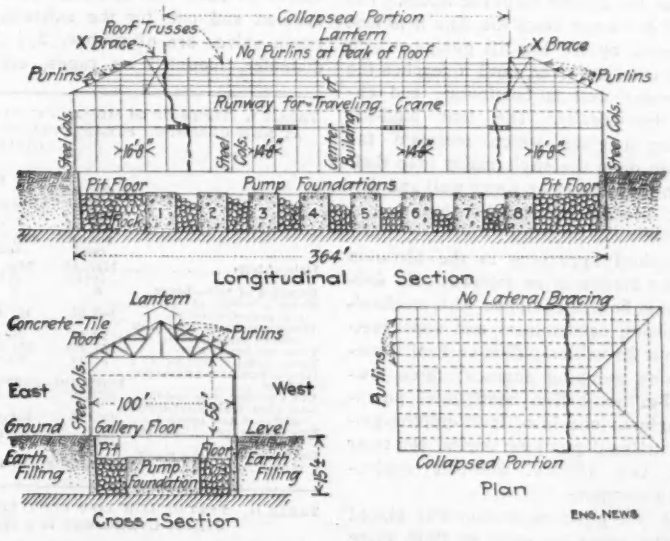
(1) The columns are not of the same form as those shown on the plans.

(2) The sizes of important members in the trusses were smaller than shown on the plans.

(3) Bolting was substituted for riveting in making important connections.

Pittsburgh Testing Laboratory of sections of the steel taken from the fallen trusses, the quality of the steel used was up to standard.

The Commission is of the opinion that the cause of the collapse was the failure of the steel trusses at the peak of the roof by the omission of the braces between them, and was not caused by any movement of the foundation wall. They recommend a system of lateral bracing in the plane of the slope of the roof between the trusses, and a similar system of braces in the plane of the bottom chord of the trusses, both systems to extend the full width and length of the building. They also recommend a system of vertical bracing between the trusses through the center of the building, and that about 6 ft. be cut off the top of the east wall, the new columns starting at the lower level. As this new level will also be the top of a proposed underground valve and meter house immediately adjoining the east wall of the pump house, the new columns would partly rest on this new structure and also on the old wall. After the columns were placed, the wall would be rebuilt to its present height, with the columns embedded. The west wall would also be reconstructed in a somewhat similar manner with bases of columns at a lower elevation than now.



OUTLINES OF PORTER AVE. PUMPING STATION, BUFFALO, N. Y., SHOWING PORTION WHICH COLLAPSED JUNE 30, 1911

(4) Smaller size purlins on the slope of the roof were used than those shown on the plans.

(5) Diagonal and longitudinal braces were not put in between all of the trusses. In our opinion they were indicated on the plans, and should have been put in.

(6) The connection of the trusses to the columns, in our opinion, was not made according to good practice, or a reasonable interpretation of the plans.

(7) We do not consider the workmanship of the steelwork up to the standard of good practice, or the requirements of the specifications.

(8) We find that a series of lattice bracing extending between the columns in the side walls were furnished and put in. This system of bracing was not shown on the plans. It was put in apparently to facilitate and aid in the erection of the steel work. According to the laboratory tests made by the

If the foregoing conclusions and recommendations are carried out it will be impossible to use any portion of the superstructure of the pump house yet standing.

It is reported that the contractor is unwilling to go so far in the repairs as the Commission advises, and the matter is now before the city officials for settlement.

Pumping Engine Tests: New Orleans Filtration Pumping Station

By L. E. Strothman*

New Orleans obtains its water supply from the Mississippi River through a cast-iron pipe line, laid beneath the low-water level, which conducts the river water to three low-lift centrifugal pumps in the pumping station. These pumps lift the water into settling basins where the heavier particles of grit and silt, which are ordinarily carried in suspension, are deposited. After this, lime and sulphate of iron are added in the mixing reservoirs, and the water passes on to the coagulating basins and then to the mechanical filters where the process of clarification and purification is completed.

An underground clear-water storage reservoir, which is connected with the clear-water well in the pumping station, receives the effluent from the filters. The flow of the water from the time it is first discharged by the low-lift pumps, which take it from the river, until it reaches the clear-water well is continuous and entirely by gravity. The four high-lift pumping engines which maintain the pressure upon the city's mains take their suction from the clear-water well and discharge directly into the distributing system.

The chief apparatus in the filtration pumping station is as follows: Six 400-hp. Heine boilers equipped with mechanical stokers, economizers and superheaters; four 20-million-gallon vertical triple-expansion pumping engines; three low-lift 40-million-gallon centrifugal pumping engines; one low-lift 20-million-gallon centrifugal pumping engine for clear water; two 150-kw. 250-volt engine-driven generators.

While the pumping station was placed in regular operation early in 1909, there were, of course, many things to be done by the contractors before it was in complete shape to turn over to the city. The final payment for all apparatus and the acceptance of the plant as a whole by the Sewerage and Water Board was based on a bonus and forfeiture plan, making it necessary to run very thorough tests on all machinery. These were carried out at various times from March to December, 1910.

All tests were conducted by employees of the Sewerage and Water Board, A. B. Wood, Mechanical Engineer, in charge of pumping stations, being in direct charge of the tests. The main objects of the tests were to determine the pumping capacity of the engines, and the duty upon which to base the payment of forfeiture or bonus. Previous to running the official tests, preliminary trials of short duration were run to familiarize the men with their respective duties, and the results of the tests were calculated independently by the engineers of the Sewerage and Water Board and of the engine builder (the Allis-Chalmers Co.), and these results were then compared and checked until both parties agreed upon the final figures.

*Manager and Chief Engineer, Pumping Engine Department, Allis-Chalmers Co., Milwaukee, Wis.

Tests of High-lift Pumping Engines

The high-lift pumping engines are known in the station as engines Nos. 1, 2, 3 and 4, and were tested in the following order, Nos. 4, 3, 2 and 1. These are of the vertical triple-expansion type, with three single-acting outside center-packed plungers, each located directly under one of the steam cylinders. The steam cylinders are 28, 54 and 80 in. in diameter, and the water plungers are 31 in. in diameter. The engines have a stroke of 60 in.

There are two eccentrics operating the valves of each cylinder, one for the admission and one for the exhaust. The pump valves are of rubber, 3⅝ in. in diameter, mounted on cages, seven of which are fastened to each of the suction- and discharge-valve decks. The steam used by each engine is condensed in a surface condenser, having 1800 sq.ft. of cooling surface, located in the main suction pipe.

According to the terms of the contract these engines were not to be credited with the steam condensed in the steam pipe connecting the boiler and engine. The drain from separator was, therefore, passed through a trap and discharged into the steam jacket of the low-pressure cylinders.

The capacity of each pumping engine was determined by plunger displacement, all pump valves having been inspected and found tight under full water pressure before test. The leakage water from plunger stuffing boxes was weighed continuously throughout the test and found to be less than 200 gal. per hour for each engine. The engineers of the Sewerage and Water Board made an additional test for slip, using a standardized pitot tube known as a Tulane Pitot Tube, and found that the capacity, determined in this manner, agreed with the capacity based on plunger displacement.

The steam consumed by the engine under test was determined by weighing the number of pounds of water pumped into the boiler supplying steam to the engine, all piping having been previously blanked off from the rest of the system. These weighings were still further checked by means of a calibrated water meter placed in the feed line between the boiler feed pump and boiler.

The results of the tests are given in Table I. It will be seen that the duty of 170,000,000 guaranteed for these engines, was exceeded by a safe margin in all cases.

TABLE I. TESTS OF 20 MILLION GALLON VERTICAL TRIPLE EXPANSION PUMPING ENGINES AT NEW ORLEANS. STEAM CYLINDERS 28 IN., 54 IN., 80 IN., DIAMETER—PLUNGERS 31 IN. DIAMETER—STROKE 60 IN.

	Engine No. 4				Engine No. 3	Engine No. 2	Engine No. 1
	60% of normal capacity 80% of normal head	normal capacity 5% increased head	Normal head 15% over capacity	Normal capacity and head	Normal capacity and head	Normal capacity and head	Normal capacity and head
Date of test	Mar. 15 1910	Mar. 16 1910	Mar. 17 1910	Mar. 18-19, 1910	Apr. 18-19, 1910	June 21-22, 1910	Sept. 20-21, 1910
Duration of test—hours	8	8	8	24	24	24	24
Steam pressure at throttle lbs. gage (corrected)	163.51	161.00	161.47	163.21	162.43	164.14	164.20
Vacuum-mercury column in exhaust pipe-in. HG	28.35	28.43	28.13	28.40	28.23	27.886	27.80
Total net head in feet	175.768	251.104	218.564	218.879	219.123	219.1285	219.0631
Temp. of water pumped F°	51.17	51.07	52.72	54.05	68.0	79.00	83.9
Rate of pumping-gallons per 24 hrs.	12,064,950	19,978,273	23,058,911	20,105,015	20,141,774	20,101,192	20,127,070
Ave. Pump hp. from test data.	372.26	880.62	884.69	772.47	773.88	771.39	771.49
Ave. i.h.p. from mechanical efficiency and pump hp.	401.92	934.64	950.15	827.85	835.99	831.33	850.33
Dry steam per i.h.p. per hour, lb.	10.61	10.83	10.75	10.58	10.466	10.51	10.51
Duty per 1000 lb. dry steam, ft.lbs.	172,847,780	172,185,913	171,444,672	174,689,922	175,130,669	174,709,100	170,833,081

TABLE II. TEST OF LOW LIFT 40-MILLION GALLON CENT. PUMPING ENGINE AT NEW ORLEANS STEAM CYLINDERS 12 AND 28 IN. DIAMETER. STROKE 24 IN.

	Engine No. 7	Engine No. 6	Engine No. 5	
	Normal capacity normal head	Normal capacity normal head	Normal capacity normal head	Normal capacity increased head
Date of test	Nov. 2, 1 10	Nov. 4, 1910	Nov. 7, 1910	Nov. 9, 1910
Duration of test hours	12	12	12	8
Steam at engine, lb. gage	165.23	162.77	165.15	164.30
Vacuum—inches hg.	26.75	26.69	26.62	26.64
Temperature of water pumped—F°	65.25	64.00	62.00	62.00
Cu.ft. water pumped per sec.	62.036	61.557	61.936	61.457
Gallons per 12 hours.	20,120,000	19,979,000	20,090,300	20,023,000
Total net head, ft.	15.064	15.855	15.867	24.973
Rev. of engine per min.	85.42	86.33	86.72	102.9
Average w.h.p. from test data	105.85	110.70	111.40	174.08
Average i.h.p. from mechanical efficiency and w.h.p.	146.90	151.10	155.9	239.70
Steam per i.h.p. per hr., lbs.	14.40	14.31	14.55	14.38
Duty per 1000 lbs. saturated steam, ft.lbs.	99,035,836	101,275,623	97,251,303	99,980,220

Tests of Large Low-lift Centrifugal Pumping Engines

These engines are known in the station as engines Nos. 5, 6 and 7, and were tested in the following order: Nos. 7, 6 and 5.

Although the contract stipulated that all tests of pumping engines were to be of 24 hours' duration, it was agreed that a shorter test would fulfill all of the requirements and intent of the contract.

The tests of these three engines, therefore, under normal conditions, were of 12 hours' duration. An overload test was run on No. 5 engine only, and as all readings were very uniform, an eight-hour test was considered sufficient.

The pumping engines consist of horizontal-shaft double-suction centrifugal pumps directly connected to horizontal cross-compound condensing Corliss engines, each pump being located between the high- and low-pressure sides of its engine and having its impeller mounted upon the main engine shaft. The steam cylinders are 12 and 28 in. in diameter and have a stroke of 24 in. The steam and exhaust valves of each cylinder are operated by independent eccentrics.

On account of the arrangement of the steam piping in the station, it was agreed that it would not be fair to charge these smaller engines with all of the condensation in the steam-pipe system. The engine was, therefore, credited with the condensation in that portion of the steam line which serves both the low- and high-lift engines.

The capacity of each centrifugal pumping engine was determined with a Venturi meter. The total head against which the pumping engine was operating was determined by piezometers attached to the suction main adjacent to the particular pumping engine under test and to the discharge main at a point about 10 ft. from the pump's discharge connection. This resulted in a direct reading in feet head of water. The total head was so small that the introduction of pressure gages or mercury columns would have decreased the accuracy of the results.

The results of these tests are given in Table II. The duty guaranteed for these pumps was 90,000,000.

Tests of the 20-million-gallon centrifugal pump for clear water showed a duty of 87,768,857 as compared with the guarantee of 85,000,000. The steam consumption of the two generator engines on test was 13.082 and 13.5 lb. per hp.-hr., respectively.

The station has been in continuous service since February, 1909, and during that period the pressure in the distributing system has never been off. The daily records which are carefully compiled show that the machinery is operating at an efficiency very close to the duties obtained during tests, which is due to the very careful management on the part of George G. Earl, General Superintendent, and A. B. Wood, Mechanical Engineer, who, with their assistants, deserve great credit for the uninterrupted success of this plant.

Exports of Steel Rails from Great Britain during the first six months of 1912 totaled 191,002 long tons, as compared with 185,088 long tons for the same period of 1911 and 223,008 in 1910. The shipments were mainly to Argentina, Australia, New Zealand and India.

The Bronx Sewer Agreement, New York City

An agreement has been reached between the members of the Bronx Valley Sewer Commission and G. W. Wickersham, Attorney General, for the federal government, terminating the contest over the plans of the Bronx Valley Sewer, so called.

Although the government started action to prevent pollution of the Hudson by the proposed trunk sewer from Bronx Borough of New York City, yet the Commissioners completed its construction under water to a point 20 ft. from the eastern bank of the river and for a time allowed sewage to be discharged. However, this use was enjoined by the New York Supreme Court in proceedings brought by the Leak and Watts Orphan House, etc., June, 1911. The federal government has at all times refused assent to construction of the sewer beyond the bulkhead line unless ample provision is made for purifying the effluent.

To end the controversy and to enable construction beyond the bulkhead line, and with a desire on the part of the federal government to secure ultimately an adequate protection of the waters of the Hudson, the following stipulation and agreement has been entered into between the United States and F. J. Hoyle, H. C. Merritt and J. L. Hayes, as members of the Bronx Valley Sewer Commission acting in behalf of themselves and of their successors in interest and control:

(I) The Bronx Valley Sewer Commissioners at once will begin the installation of a plant for the partial purification of the effluent of the Bronx Valley sewer system by screening and sedimentation with an efficiency sufficient to remove and which shall at all times remove from said effluent enough of the putrescible contents to purify the same to the extent of 10% upon an absolute putrescibility scale. This plant shall be completed and put into operation on or before the first day of May, 1913; and it or one not less efficient shall be kept in continuous operation producing at least the results above specified so long as the Bronx Valley sewer continues in use.

(II) At all times during the operation of the Bronx Valley sewer system, in addition to those specified in the paragraph immediately above, the requirements enumerated under the seven heads immediately following will be met either through the plant and installations above called for or through requisite additional arrangements:

(1) There will be absence in the Hudson River of suspended particles visible to the naked eye coming from the effluent of said sewer.

(2) There will be absence of deposits in the waters of the Hudson River coming from the effluent of said sewer which the Secretary of War, exercising a reasonable discretion, may find objectionable.

(3) There will be absence in the waters of the Hudson River and its vicinity of any odor due to the putrefaction of organic matter contained in the effluent of said sewer which the Secretary of War, exercising a reasonable discretion, may find objectionable.

(4) There will be a practical absence on the surface of the Hudson River, at the dispersion area or elsewhere, of any grease or color due to the discharge of said sewage.

(5) There will be no public or private nuisance occasioned by the discharge from the said sewer.

(6) The effluent from said sewer shall not injuriously affect property of the United States situated in the Hudson River.

(7) There shall be excluded from the sewer all refuse matters of the classes forbidden by law to be discharged into the navigable waters of the United States.

(III). At any time subsequent to Jan. 1, 1917, or to the date when there shall be 50,000 persons contributing sewage to said sewer—whichever date first arrives—the Secretary of War may designate a board of three men, which shall make inquiry into the pollution of the Hudson River by the presence therein of sewage, filth and refuse matter, and upon a view of the facts and circumstances thought to deserve consideration, this board shall determine and thereafter report to him what, if any, purification of the effluent of the Bronx Valley sewer, in addition to that specified in the foregoing sections of this stipulation and irrespective of what others in fact may be doing towards bringing about the end desired, ought to be required in order to impose upon said sewer, its managers and the territory served by it, the performance of their just, fair and equitable part of whatever may be necessary for the restoration and maintenance of the waters of the Hudson River to such degree of purity as will render them adequate for the support of shad and other major fish life.

After receiving the report of this board, the Secretary of War may, from time to time, direct such further degree of purification of the effluent of the Bronx sewer not in excess of the findings of the board as he may think proper; and within two years after receiving such directions, the Bronx Sewer Commissioners or their successors in control shall cause the same to be brought up to the required standard.

The board of three appointed by the Secretary of War shall include one member designated by the Bronx Valley Sewer Commissioners or their successors, provided he be named within thirty days after request therefor, and provided further that all expenses incident to his services shall be borne by those in whose behalf he is designated. A majority of the board may act and a report concurred in by two members shall be the report of the board.

(IV) At all times hereafter, through such representatives as may be designated, the Secretary of War shall have full opportunity to inspect the construction of proposed purification plant and the condition and working of the entire sewer system, in order to determine whether the terms and provisions hereof are being observed in all respects; and to this end the Commissioners will render such expert or other assistance as he may request. Said Secretary at all times shall have the right to decide whether such terms and provisions are being complied with; and upon notice

from him that they are not, the Commissioners or their successors shall forthwith do whatever may be necessary in order to effect compliance therewith.

(V) Full compliance at all times with the terms and requirements of this stipulation shall be and remain the express condition of any permits issued by or on the part of the United States for the construction and future maintenance and operation of the Bronx Valley sewer or any part thereof.

(VI) This stipulation shall not become effective unless and until all such permits as may be requisite under the statutes of the United States for the construction, maintenance and operation of said sewer, according to the plans and specifications heretofore prepared, are actually obtained or unless or until such permits are made conditional upon compliance at all times with all the terms thereof.

(VII) As soon as the permits contemplated in the section immediately preceding have been issued and this agreement properly executed, has been filed in the office of the Clerk of the Supreme Court as a stipulation between the parties in the above entitled cause, the United States will cause the bill of complaint to be dismissed, but without prejudice.

(VIII) Nothing herein contained shall hinder or interfere with the assertion or execution by the United States of their rights and powers granted by the Constitution or Statutes.

The Homestead Works Testing Laboratory, Homestead, Pa., was destroyed by fire on the morning of July 25th, the building and all testing machines, machine tools, and other contents being destroyed.

A Locomotive Boiler Exploded July 20 on the St. Louis, Brownsville & Mexico R.R., five miles south of Bay City, Tex. The conductor, engineer and fireman, who were riding in the cab, were killed. The locomotive was demolished and 10 box cars of the freight train which it was pulling were wrecked.

A Premature Explosion of Blasting powder, July 23, caused the death of four men at the railway construction camp of Wheaton & Co., one of the contractors on the new Canadian Pacific line, near Maberly, Ont.

A Celluloid Factory Fire in London, England, July 23, caused the death of seven girls and the fatal injury of five others. The fire started in a front room on the top floor of a four-story Christmas card factory in Moor Lane. The employees in the rear part of the building were cut off from the stairs by the quick spread of the flame.

The Explosion of a Carload of Dynamite stored in a shed near Manitowoc, Wis., July 19, caused the death of one man and, according to press reports, caused widespread damage over an area of two miles.

A Contractor's Locomotive figured in a grade-crossing accident at Gerard Ave. and 149th St., New York City, July 22. The locomotive was being operated by Rogers & Haggerty, contractors, who are building a part of the new subway system. The narrow gage track of the construction railway crosses the trolley-car tracks on 149th St. at grade. The collision resulted apparently from the negligence of the flagman stationed at the crossing.

A Cloudburst, July 24, at Evans Station, three miles north of Uniontown, Penn., caused the flooding of Superba mine No. 2. Thirteen men were drowned in the mine. Officials of the Superba Co. state that it will take at least 60 days to clear the mine of water.

The entire western part of Pennsylvania sustained an unprecedentedly heavy rainfall during the month of July and much damage was done by flood at a number of small towns. The storm of July 24 was especially severe throughout the territory along the Monongahela River, southeast of Pittsburgh.

The Failure of Several Dams on the Wisconsin River, north of and at Wausau, Wis., July 24, caused damage estimated at about $1,000,000. Three bridges in Wausau were carried away and the city's water supply was cut off.

A Grade-Crossing Accident, July 28, at Alexis, near Toledo, Ohio, caused the death of six persons and the injury of three others. A Lake Shore & Michigan Southern Ry. train struck an automobile containing the nine victims at a crossing where the view of the railroad track was obscured by a corn field.

The Cause of the Wreck of the Twentieth Century Limited on the New York Central & Hudson River R.R. at Hyde Park, N. Y., Mar. 13, 1912, was not a broken rail as has been generally supposed. This at least is the finding of the New York Public Service Commission, Second District, as the result of its investigation of the accident. It will be recalled that four cars of the train were derailed at high speed and went down the low embankment to the edge of the Hudson River, where they were stopped by the thick ice. The Commission's report states that the breaking of the rail appears to have been the result of the accident and not the cause, and presents the following conclusions as to the cause of the wreck:

1. That the broken rail was a result of the derailment rather than a cause.
2. That the rail broke because of the terrific blows delivered to it by the wheels jumping over the angle-bars at its north end while it lay on its side with the head to the west, a position at which it was least able to withstand the impact of the blows.
3. That the probable cause of the derailment was the irregularity in superelevation shown, which caused excessive lateral pressure on the head of the high rail, sufficient to pull the inside spikes and overturn the rail.
4. That this condition existed during at least 12 hours prior to the derailment and was probably cumulative in result, each succeeding train which passed over the track decreasing the holding power of the spikes until complete failure took place on the passage of the wrecked train.

The Commission expresses itself strongly in favor of a reduction in the speed of passenger trains, especially during the winter season, and states that as a result of a conference with the officials of the New York Central and Pennsylvania Railroads it is expected that the schedule of the Twentieth Century Limited and the Pennsylvania's 18-hr. train will be lengthened from 18 to 20 hr. during the coming winter.

The La Salle St. Tunnel, under the Chicago River, was put in service by the Chicago Railways Co. on July 21, thus relieving the street railway traffic over the bridges across the main arm of the river. The river portion of the tunnel consists of a 280-ft. twin-tube steel sheel which was partly lined with concrete before being sunk in place in a dredged trench. The construction work on this tunnel has been described in our issues of Jan. 5, April 13, Aug. 10 and Sept. 21, 1911.

A Typhoid Fever Epidemic is now threatening Ottawa, Ont. According to the Ottawa "Journal," the situation has suddenly assumed a serious aspect. The city health officer has warned all persons to boil the city water. Although only a few days have elapsed since the city health officials have acknowledged that the water is polluted there are at least 60 cases of typhoid fever in the city, and many more suspected cases. A very serious outbreak occurred early in 1911, and was shown conclusively to be due to the pollution of the city water, which comes from the Ottawa River near the city. The cause and extent of the 1911 outbreak was described by Dr. P. H. Bryce, Chief Medical Officer, Department of the Interior, Ottawa, Ont., in "Engineering News" of Mar. 23, 1911.

The Cape Cod Canal Construction work is annoying to some of the wealthy summer colony at Agawam Point, Buzzards Bay, Massachusetts. A preliminary injunction was asked in a suit brought by several prominent men to restrain the Cape Cod Construction Co. from continuing the work of dredging on the ground that the work disturbs their slumbers and impairs their health. Fortunately the judge refused to grant such an injunction, although he has summoned the construction company to make specific answers to the complaints.

The Steel Tube Tunnels under Harlem River for the new Broadway-Lexington Ave. subway in New York City have been contracted for. There are to be four tubes encased in concrete. This is Section 14 of the new subway and the contract has been let to Arthur McMullen and Olaf Hoff for $3,889,775. The contract for Section 2-A, which embraces the Canal St. station has been let to the O'Rourke Engineering Construction Co. for $912,351. There are now 12 of the 16 sections of the Lexington Ave. subway under contract, a total of 8 miles of 4-track railway out of the total of 12 miles planned. The total contract for all sections is for $35,521,291. The total number of workmen employed in this work is 3280. The Fourth Ave. subway in Brooklyn and the Center St. loop in New York are nearing completion. Including these two lines the total amount of work under contract for the new subway system amounts to $61,000,000.

The Gowan Safety Mitering Device for canal lock-gates, described on p. 43 of our issue of July 11 in connection with the recent accident on the Welland Canal, had a successful test in the case of a previous accident on this canal. According to the "St. Catherine's Standard" of May 22, 1912, an accident occurred in Lock No. 24 of the canal on the evening of May 18. The large steamer "Beaverton," had entered the lock when the steel cable securing her broke. She surged ahead against the closed gates at the upper end of the lock, pushing them about a foot out of miter. The water rushed through in a flood against the bow of the boat and helped to check her speed. As the gates came together again, the locking device held them in true position so that they mitered properly and withheld the water. Had this device not been in use and had the gates failed to miter in closing, the entire level above, a mile in length, would have been emptied and very serious damage would have been done.

The Bubonic Plague Situation in Porto Rico continues to be serious. About 50 cases and half as many deaths had been reported up to July 25. Examinations of the rats killed show that the percentage of infection runs as much as 2.6%, which is considered high. Rat extermination measures are now being taken at nearly all South Atlantic and Gulf ports of the United States.

Another source of infection to which travelers in steamships in the tropics are particularly liable is from bedbugs. In an article in the July 27 issue of the "Medical Record" it is stated that results of experiments on guinea pigs have definitely proved that the ordinary bedbug, cimex lectularius, transmits plague, and that as such an agent of transmission the bedbug is to be more feared than the flea.

Specifications for Concrete Work placed under the direction of the Bureau of Yards and Docks of the Navy Department, have been issued under the title "Specifications for Concrete and Concrete Materials and Mortar and Mortar Materials No. 5902," dated Mar. 25, 1912. These specifications were prepared and edited by Civil Engineer R. E. Bakenhus, U. S. N., and then were submitted to the civil engineers at the principal navy yards and to a number of contracting firms for comments, the present edition being the revised form after such procedure. Copies of the specifications may be obtained by writing to the Bureau of Yards and Docks, Washington, D. C. They are particularly well written and clearly stated, and should be of value to engineers in preparing specifications for concrete work. Special attention might be called to the sections on proportioning materials in concrete in which provision is made for a variable proportion of sand, depending upon the density of the sand and stone mixture, a reprint of which appears on p. 201 of this issue.

The Famous Fort McHenry at Baltimore, Md., which for many years was one of the main defenses of the harbor, is to be abandoned as a military post by the United States Government. It was the bombardment of Fort McHenry in 1814 by the British fleet that inspired the writing of the "Star-Spangled Banner" by Francis Scott Key, a prisoner of war on one of the British vessels. The fort has had no modern battery, but is equipped with many large and useful buildings, including a hospital. Forts Carroll and Armistead, two of Baltimore harbor's other defenses, were abandoned last fall, as they are no longer considered necessary. Fort Howard, which is some distance below the city and is fully equipped with modern coast defense armament, takes the place of all three of the old forts.

A Sewage Treatment Tank on the Imhoff system, designed for Winchester, Ky., by Chas. E. Collins, of Philadelphia, is claimed to infringe the Cameron septic tank patent No. 634,423. Suit for infringement has been brought against the City of Winchester by the Cameron Septic Tank Co., of Chicago. In the suit it is claimed that the Imhoff tank is merely an application of the septic process and is covered by the process claims of the Cameron patent. To support this ground a quotation is made from Fuller's recent work on Sewage Disposal, in which the Imhoff tank is referred to as "a two-story septic tank."

The 5000-ton Testing-Machine of the Bureau of Standards, orginally designed and ordered by the U. S. Geological Survey, has been erected (in half its full height) and suitably housed at the Pittsburgh laboratory of the Bureau, 40th and Butler Sts. Plans have been laid for immediate large-scale work. The machine as now erected will take compression specimens about 30 ft. long. A brick pier 46 in. square by 12 ft. long will be the first test object. Such a pier is now being laid up in the machine, with cement mortar, and after it is tested a similar lime-mortar pier will be laid up. It is expected that concrete sections of the same size will be included in this group of tests. The work will probably go ahead slowly because it is thought best to build the various specimens directly on the bed of the machine. Arrangements for a more efficient procedure will doubtless be made soon, however.

A Catskill Aqueduct Blasting Accident July 29, in the north heading of Shaft 13, at 93d. St. and Central Park West, New York City, killed three men and injured five others. The charge of dynamite in a missed hole was struck by a drill.

Engineers Interested in Archaeology would enjoy being members of the Canadian Northern Ry. construction parties in British Columbia. The Canadian Geological Survey has just received a fifth shipment of human bones and other relics of the ancient inhabitants of the Northwest, under orders issued by Sir William Mackenzie, President of the road, to all his engineers. The most recent shipment comes from Kamloops, B. C., and the specimens were ploughed up in a borrow pit in the side of the Barrier River. The soil is sand, and owing to the dry climate the bones were in an excellent state of preservation. There are many circular pits along the river bank at this point, which are evidently the remains of ancient subterranean dwellings.

Personals

Mr. A. Swartz, Division Engineer at Huntington, Ind., of the Erie R.R., has resigned.

Mr. Henry W. E. Rabe has been appointed Superintendent of the waterworks and sewerage departments of Galveston, Tex.

Mr. R. P. Edson, Assistant Superintendent of the Chicago, Milwaukee & St. Paul Ry., at Mitchell, S. D., has been promoted to be Superintendent at Des Moines, Iowa.

Mr. E. L. Magers, formerly Assistant Superintendent of the St. Louis & San Francisco R.R., at Ft. Scott, Kan., has been promoted to be Superintendent at Sapulpa, Okla.

Mr. E. T. Lamb, President and General Manager of the Norfolk Southern R.R., at Norfolk, Va., has resigned to become President of the Atlanta, Birmingham & Atlantic R.R., at Atlanta, Ga.

Mr. M. J. Larson, formerly Trainmaster at Sioux City, Iowa, of the Chicago, Milwaukee & St. Paul Ry., has been promoted to be Assistant to the Assistant General Manager, at Chicago, Ill.

Mr. J. C. Mill, Signal Inspector of the Chicago, Milwaukee & St. Paul Ry., has been promoted to be Assistant Signal Engineer, with office at Milwaukee, Wis., succeeding Mr. H. K. Lowry, resigned.

Mr. W. A. Webb, formerly Assistant to the President of the Missouri, Kansas & Texas Ry., has been promoted to be General Manager. Mr. Webb was formerly General Manager of the Texas Central Ry.

Mr. Joseph W. Shirley, Chief Engineer of the Topographical Survey Commission of Baltimore, Md., has been appointed a member of the Baltimore City Planning Commission, succeeding Mr. W. H. Fehsenfeld.

Mr. Edward Gray, M. Am. Soc. C. E., Engineer of Maintenance-of-Way of the Southern Ry., at St. Louis, Mo., has resigned to become associated with the Jones-Gray Railroad Construction Co., of Louisville, Ky.

Mr. M. H. Cahill, recently Assistant Superintendent of the Baltimore & Ohio R.R. at Pittsburgh, Penn., is now Superintendent with headquarters at Newark, Ohio, succeeding J. F. Irwin, who has been assigned to other duties.

Mr. G. A. Haggander has been appointed Assistant Bridge Engineer of the Chicago, Burlington & Quincy R.R., at Chicago, Ill., succeeding Mr. L. J. Hotchkiss, M. Am. Soc. C. E., who has resigned to engage in a contracting business.

Mr. N. E. Brooks, M. Can. Soc. C. E., Division Engineer of the western division of the Canadian Pacific Ry. at Calgary, Alta., has been appointed Acting General Superintendent of the division, succeeding Mr. A. Price, who is on leave of absence.

Mr. James E. Barlow, Assoc. M. Am. Soc. C. E., Engineer with the Bureau of Municipal Research, Cincinnati, Ohio, has been appointed Principal Assistant City Engineer of Cincinnati at a salary of $3600 per annum, succeeding Mr. G. D. Baker, resigned.

Mr. Frank Zeleny, formerly Assistant to the Superintendent of Shops of the Chicago, Burlington & Quincy R.R., at Aurora, Ill., has been appointed Engineer of Tests, succeeding the late W. A. Derby. Mr. Zeleny will retain his headquarters at Aurora.

Mr. H. F. Anderson, formerly Superintendent of the Galveston, Harrisburg & San Antonio Ry., at San Antonio, Tex., has been appointed Superintendent of the Missouri, Kansas & Texas Ry. of Texas, at Denison, Tex., succeeding Mr. J. Munday, resigned.

Mr. R. C. Morgan, formerly Superintendent of the Great Northern Ry., at Marcus, Wash., is now Superintendent of Terminals of the Canadian Pacific Ry., at Fort William, Ont. Mr. Morgan began railway work in 1877 as a stenographer in the general freight office of the Northern Pacific Ry.

Messrs. F. M. Bowman, M. Am. Soc. M. E., Wayne Rawley and A. H. Bovard announce their resignations from the Riter-Conley Manufacturing Co., of Pittsburgh, Penn., to accept positions with the Blaw Steel Construction Co., of Pittsburgh, as Vice-President, General Manager and Chief Engineer, respectively.

Mr. Robert E. Strahorn, Vice-President of the Oregon-Washington R.R. & Navigation Co., has been elected President of the Portland, Eugene & Eastern Ry. and will have charge of extensive electric railway developments which are being undertaken by the Southern Pacific Ry. interests in the Willamette River Valley in Oregon.

Mr. R. S. Lea, M. Am. Soc. C. E., of Montreal, Que., is now associated with

Mr. H. S. Ferguson, M. Am. Soc. C. E., of New York City, under the firm name of Lea & Ferguson, consulting engineers on paper and pulp mill equipment and hydraulic developments. Mr. Lea has recently moved his office in Montreal to 820 New Birks Bldg.

Mr. James W. Rickey, M. Am. Soc. C. E., Chief Engineer of the Long Sault Development Co. and the St. Lawrence Power Co., Ltd., and Hydraulic Engineer for the Aluminum Co. of America, has moved his offices from Massena, N. Y., to 2402 Oliver Bldg., Pittsburgh, Penn.

Mr. Daniel E. Moran, M. Am. Soc. C. E., has been engaged as an engineering expert by the property owners on William St., New York City, to gather information and give advice in a contest to prevent the building of a subway in William St. The property owners object to the building of the subway on the ground that the work will endanger the foundations of many tall buildings.

Mr. Alexander L. Black, M. Am. Soc. C. E., Engineer of the New Orleans Ry. & Light Co., New Orleans, La., has become associated with the firm of Ford, Bacon & Davis, Engineers, New York City, as Engineer in charge of southern properties. Mr. Black is a native of New Orleans and received his engineering education at the School of Mines, Columbia University, New York City, where he graduated in 1890, at the age of 19 years. For three years he was engaged in mining work in the West and in Mexico. Since 1894 he has been connected with the street railways of New Orleans.

Mr. S. H. McCrory, who has been with the United States Bureau of Drainage Investigations since 1906, has been appointed Chief Engineer of the Bureau, succeeding Mr. C. G. Elliott, M. Am. Soc. C. E., whose summary removal has caused much comment. Mr. McCrory's appointment comes as a result of the recent civil service examination, announced in our columns of May 23, and is considered by an engineer who is familiar with his work to be well deserved. This acquaintance states that Mr. McCrory's service "has been characterized by energy, patience and engineering judgment. In all his work the determining motive has been not so much a desire for self advancement as serious concern for the best interests of the service." Of the engineers who took the examination for the position of Chief Engineer, the three who ranked highest were all men who had worked for several years under Mr. Elliott.

Obituary

Horace E. Horton, M. Am. Soc. C. E., Proprietor of the Chicago Bridge & Iron Works, Chicago, Ill., died at his home in Chicago, July 29, at the age of 69 years. A biographical sketch of Mr. Horton will appear in a later issue.

Isaac McHose, a pioneer iron manufacturer of Reading, Penn., died July 24. He was nearly 90 years old, and was a builder of anthracite iron furnaces in the decade before the Civil War. He was founder of the firm of McHose & Co., of Reading, which was established in 1852. He was the first President of the Keystone National Bank of Reading, and served his home city in various public capacities. Mr. McHose is survived by a daughter and three sons.

William A. Derby, Acting Engineer of Tests of the Chicago, Burlington & Quincy R.R., at Aurora, Ill., died at the city hospital at Aurora, on June 30. He was born at Burlington, Iowa, in 1872, and received his education at Iowa College and the Armour Institute of Technology. In 1898 he began engineering work with the Chicago, Burlington & Quincy R.R. in the Aurora laboratory. In 1905 he was promoted to be Assistant Engineer of Tests, and in 1910 Acting Engineer of Tests.

H. J. Beemer, one of the best known contractors of Eastern Canada, died in London, England, on July 23. For the past 20 years he had made his home in Quebec, Que., where he was connected with the building of the Quebec & Lake St. John Ry. and the Quebec & Montmorency Ry. He was also one of the promoters of the Quebec street railway system. Mr. Beemer had mining interests in Arizona and Mexico, where he spent some time before going to England in search of health.

William Alford Richards, former United States Surveyor General of Wyoming and an ex-Governor of Wyoming, died in Australia, on July 26. He was born at Hazel Green, Wis., Mar. 9, 1849. From 1866 to 1869 he was a school teacher in Wisconsin; he then went to Omaha, Neb., where he studied surveying. Later he emigrated further West and in 1879 went to Santa Clara, Calif., where he became County Surveyor. He soon moved to Colorado Springs, Colo., where he became County Surveyor of El Paso County and later City Engineer of Colorado Springs. In 1884 Mr. Richards moved to the Wyoming Territory and from 1889 to 1893 was Surveyor General. In 1894 he was elected Governor of the State of Wyoming, and after serving a four-year term declined a renomination. From 1899 to 1903 he was Assistant Commissioner of the General Land Office, and for the four following years Commissioner. From 1909 until recently he was Commissioner of Taxation of the State of Wyoming.

Engineering Societies

COMING MEETINGS

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 26-30. Annual convention at Peoria, Ill. Secy., Clarence R. George, Houston, Tex.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 27-30. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. car shops, East Buffalo, N. Y.

INTERNATIONAL CONGRESS FOR TESTING MATERIALS.
Sept. 2-7. Sixth congress at New York City. Secy. of organizing committee, H. F. J. Porter, 29 West 39th St., New York.

MICHIGAN GAS ASSOCIATION.
Sept. 4-6. Annual convention at Toronto, Ont., and on board steamer "Rochester." Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.
Sept. 4 at Washington.
Sept. 6-13 at New York City. Secy., Bernhard C. Hesse, 25 Broad St., New York.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 7-10. Annual meeting at New York City. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Penn.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 10-13. Annual convention at Denver, Colo. Secy., A. P. Dane, B. & M. R.R., Reading, Mass.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 12-14. Annual convention at Glenwood Springs, Colo. Secy., Thos. F. Kennedy, 900 15th St., Denver, Colo.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 16-19. Annual convention at Niagara Falls, Canada. Secy., P. S. Millar, 29 West 39th St., New York.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 18-20. Annual convention at Washington, D. C. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 18-20. Annual meeting at Washington, D. C. Secy., Selskar M. Gunn, 755 Boylston St., Boston, Mass.

INTERNATIONAL CONGRESS ON HYGIENE AND DEMOGRAPHY.
Sept. 23-28. Fifteenth congress at Washington, D. C. Secy., John S. Fulton, Senate Annex, Washington, D. C.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Sept. 24-26. Annual convention at Buffalo, N. Y. Secy., R. D. Moldenke, Watchung, N. J.

NATIONAL IRRIGATION CONGRESS.
Sept. 30-Oct. 3. Annual meeting at Salt Lake City, Utah. Secy., Arthur Hooker, Salt Lake City.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENTS.
Sept. 30-Oct. 5. Annual convention at Atlantic City, N. J. Secy., G. E. Pennybacker, Jr., Colorado Bldg., Washington, D. C.

Illuminating Engineering Society—At a special meeting to be held on the evening of Aug. 1, Mr. Leon Gasper, Honorary Secretary of the British Illuminating Engineering Society, will give an address on "Progress in Illuminating Engineering in Europe."

International Railway Congress—The next congress is to be held at Berlin, Germany, in 1915. The committeemen appointed to present papers on specific subjects have been announced as follows: First Section—"Method of Construction of Roadbed and Tracks," H. U. Mudge; "Study of Maintenance and Supervision of Tracks," Epes Randolph; "Special Steels," W. C. Cushing; "Reinforced Concrete," C. H. Cartlidge.

Second Section—"Passenger Equipment," B. F. Bush; "Electric Traction," Horace G. Burt.

Third Section—"Passenger Terminals," F. A. Delano; "Freight Terminals," W. S. Kinnear.

Fourth Section—"The Relation of Cost of Service to Rates," Fairfax Harrison; "Interchange of Equipment and Demurrage Charges," Arthur Hale; "Workmen's Dwellings," A. F. Banks.

Fifth Section—"Special Type of Traction Units for Branch Lines," H. M. Spencer.

American Society for Testing Materials—The list of the standard specifications prepared by this Society as revised for 1912 shows a total of 52, which represents an increase of 13 specifications in comparison with the 1911 list. The subjects of the new specifications are as follows: Wheels for engine and passenger service; wheels for freight service; nickel steel; automobile steels; girder and high tee rails; engine-bolt iron; refined rough iron bars; medium hard-drawn copper wire; soft or annealed copper wire. Locomotive materials—annealed steel forgings; steel boiler tubes; shapes, plates and bars; iron boiler tubes. Single copies of any of these specifications may be obtained from the Secretary, Edgar Marburg, University of Pennsylvania, Philadelphia, Penn., at 25c. each.